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Idaho Habitat/Natural Production Monitoring Part I

General Monitoring Subproject

U.S. Department of Energy
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Division of Fish & Wildlife

Idaho Department of
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IDAHO HABITAT/NATURAL PRODUCTION MONITORING

Part I

General Monitoring Subproject

Annual Report 1990

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has been monitoring and evaluating proposed and existing habitat improvement projects for rainbow-steelhead trout Oncorhynchus mykiss, hereafter called steelhead, and chinook salmon O. tshawytscha, hereafter called chinook, in the Clearwater and Salmon River drainages (Figure 1) for the past seven years. Projects included in the evaluation are funded by, or proposed for funding by, the Bonneville Power Administration (BPA) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers. This evaluation project is also funded under the same authority (Fish and Wildlife Program, Northwest Power Planning Council).

A mitigation record is being developed using increased carrying capacity and/or survival as the best measure of benefit from a habitat enhancement project. Determination of full benefit from a project depends on completion or maturation of the project and presence of adequate numbers of fish to document actual increases in fish production. The depressed status of upriver anadromous stocks has precluded measuring full benefits of any habitat project in Idaho. Partial benefit is credited to the mitigation record in the interim period of run restoration.

Agency and tribal roles for implementation, monitoring, and evaluation of Idaho habitat projects were established in the 1985 BPA Work Plan (BPA 1985). Project implementors have the major responsibility for measuring physical habitat and estimating habitat change. To date, Idaho habitat projects have been implemented primarily by the U.S. Forest Service (USFS). The Shoshone-Bannock Tribes (SBT) have sponsored three projects (Bear Valley Mine, Yankee Fork, and East Fork Salmon River projects). IDFG implemented two barrier removal projects (Johnson Creek and Boulder Creek) that the USFS was unable to sponsor at that time. The role of IDFG in physical habitat monitoring is primarily to link habitat quality or habitat change to changes in actual and potential fish production.

Estimation of anadromous fish response to BPA habitat projects in Idaho is generally the responsibility of IDFG (BPA 1985). However, the SBT have primary responsibility for developing the mitigation record for the three projects that they have sponsored.

Approaches to monitor habitat projects and document a record of credit were developed in 1984-1985 (Petrosky and Holubetz 1985, 1986). The IDFG evaluation approach consists of three basic integrated levels: parr density monitoring, parr standing stock evaluations, and estimation of survival rates between major freshwater life stages (egg, parr, smolt) of chinook and steelhead. The latter is referred to as "intensive studies." Annual general monitoring of anadromous fish densities in a small number of sections for each project is being used to follow population trends and define seeding levels. For most projects, standing stock estimates of parr will be used to estimate smolt production based on survival rates from parr to smolt stages. Intensive studies (Kiefer and Forster 1990) estimate survival rates from egg-to-parr and parr-to-smolt and provide other basic biological information that is necessary to evaluate the Fish and Wildlife Program.

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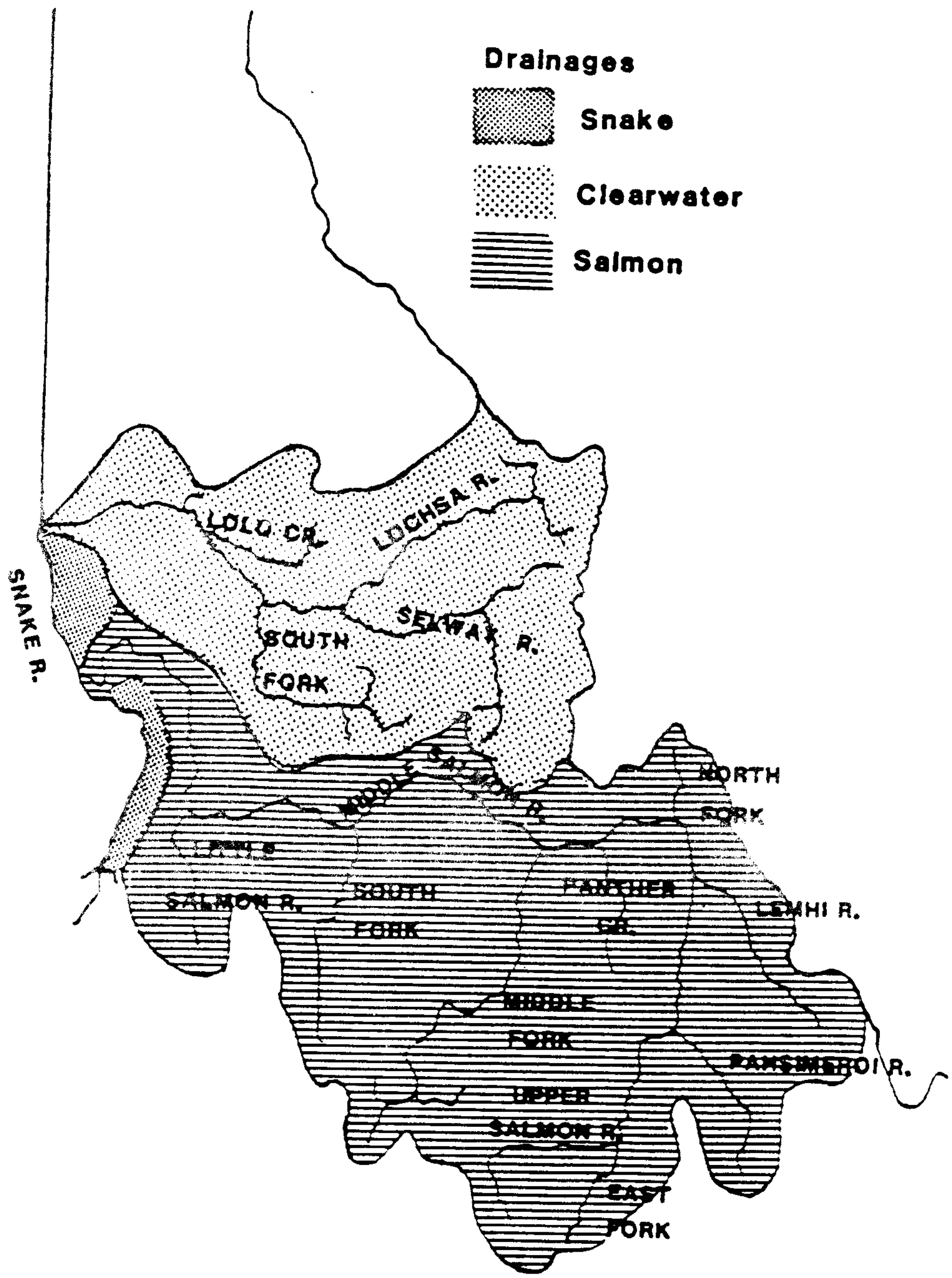

Figure 1. Idaho's remaining anadromous fish waters showing major drainages of the Clearwater, Salmon, and Snake river subbasins.

A physical habitat and parr density database has been developed for BPA habitat projects in Idaho. The data will be integrated among the three evaluation levels. The schedule of BPA habitat project implementation and IDFG general monitoring-evaluation activities from 1983-1989 is presented in Table 1. A complete mitigation record will be made when three conditions are met: 1) the habitat project is completed or at full maturation; 2) the fish population affected is observed at full seeding, or a full seeding level has been determined for the affected habitat type; and 3) the appropriate survival rates from summer parr stage to smolt stage have been determined from the intensive studies. Although most fish populations have not approached full seeding, the general and intensive monitoring results provide inferences into effectiveness of habitat projects and the status of wild/natural anadromous fish in Idaho.

After a habitat enhancement project has been implemented and prior to the time that the aforementioned conditions have been met, IDFG has constructed a partial mitigation record based on estimated increases in parr and smolt production. Monitoring data are essential to establish trends and estimate partial benefits during the years that project evaluations are not conducted.

The year 1990 was a transition year for the general monitoring subproject. The long-term direction of this project, beginning in 1991, is to monitor success of the Fish and Wildlife program in Idaho's Salmon, Clearwater, and Snake River subbasins to determine the increased production of wild and natural salmon and steelhead due to improved flow/passage conditions and other production enhancement activities. With this direction, habitat project benefits will continue to be monitored secondarily to overall production.

In 1990, the general monitoring and evaluation project focused on:

1) General density monitoring,
2) Estimates of BPA habitat project benefits,
3) Comparisons of densities in sections treated and not treated with instream structures in Laic) Creek and Crooked River,
4) Estimates of chinook and steelhead total abundance and egg-to-parr survival in Rapid River based on known adult escapements,
5) Estimates of chinook total abundance and egg-to-parr survival in Johnson Creek above the barrier removal project based on the 1989 redd count,
6) Correlation of chinook and steelhead redd densities with subsequent parr densities,
7) Increased pre-response sampling effort in the Camas Creek project area,
8) Comparisons of anadromous fish populations at different levels of sedimentation and riparian degradation, and
9) Comparisons of densities and percent Carrying capacities between wild and natural populations of both steelhead and chinook.

METHODS

Project 83-7 has been monitoring parr densities in stream sections within the Clearwater and Salmon River drainages since 1984. Additionally, the IDFG fisheries research section and regional fisheries programs have monitored parr

Table 1. Schedule of BPA project implementation (I) and evaluation activities (P = pretreatment evaluation, M = monitoring, and E = post-treatment evaluation) in Idaho, 1983-1988.

Project	Project type[a]	1983	1984	1985	1986	1987	1988	1989	1990
Lolo Creek	IS	I	I,P,E	E	M	M	M	M	E
Eldorado Creek	PA	-	I,P	I,M	E	M	M	M	M
Upper Lochsa River	IS	I	I,E	M	M	M	M	M	M
Crooked Fork Creek	PA	-	I,P	I,P	E	E	E	E	M
Colt Creek	PA	-	-	-	I	M	M	M	M
Crooked River	PA	-	I,P	M	E	M	M	E	E
	IS	-	I,P	I,P,M	E	M	M	M	E
	OC	-	I,M	I,M	I,E	I,M	I,E	E	E
Red River	BC	I	I,M	M	M	M	M	M	M
	IS	I,M	I,M	I,M	E	M	M	M	M
	RR	-	-	-	-	-	-	-	-
Meadow Creek	PA	-	-	-	-	I,M	M	M	M
Panther Creek	SP	-	P	M	M	M	M	M	M
Pine Creek	PA	-	-	-	-	I,M	M	-	-
Lemhi River	IF	-	-	P	M	M	M	-	M
Upper Salmon River	IF	-	P	P	M	P	P	P	P
	RR	-	M	P	M	P	P	P	P
Alturas Lake Creek	IF	-	P	M	M	P	P	P	P
Pole Creek	PA	I	M	M	M	E	E	E	E
	RR	-	M	P	M	P	M	M	M
Valley Creek	RR	-	-	P	M	M	M	M	M
	PA	-	-	P	M	M	I,M	M	M
Bear Valley Creek	SP	-	I,P	I,P	I,M	M	M	M	M
	RR	-	M	P	P	M	I,M	I,M	M
Elk Creek	RR	-	M	P	P	M	I,M	I,M	M
Marsh Creek	RR	-	M	P	M	M	M	M	M
Knapp Creek	PA	-	M	P	M	I,M	M	M	M
Camas Creek	RR	-	M	M	M	M	I,M	M	E
	BC	-	M	M	M	M	M	M	E
Johnson Creek	PA	-	I,P	I,E	I,E	E	E	M	E
South Fork Tributaries	PA	-	-	-	I,M	M	M	M	M
Boulder Creek	PA	-	P	I,P	E	M	E	M	M
Loon Creek	CO	-	-	M	M	M	-	M	M
Sulphur Creek	CO	-	M	M	P	M	M	E	M
South Fork Salmon	CO	-	M	M	M	M	M	M	M

[a]BC = bank-channel rehabilitation
CO = control stream
IF = improved flows
IS = instream structure
OC = off-channel developments
PA = passage
RR = riparian revegetation
SP = sedimentation and pollution control.

TABL90

densities in stream sections in coordination with the evaluation project, so that parr densities are being monitored in all major anadromous fish production areas of Idaho. Other contributors to the monitoring data set include the U.S. Fish and Wildlife Service's Fisheries Resource Office in Ahsahka and the Bureau of Land Management at Cottonwood. We anticipate adding sections from the Forest Service and Tribes in 1991. The number of sections monitored annually since 1984 is shown in Table 2.

Physical Habitat

Monitoring sections provide an annual index of anadromous fish abundance in different habitat types and drainages. Monitoring sections are approximately 100 m long with boundaries at defined breaks between habitat types; sections included at least one riffle-pool sequence. Streams, project strata, and sections were cross-referenced to the Environmental Protection Agency (EPA) reach numbering system (NPPC and BPA 1989). Sections monitored in 1990 are listed in Appendix A-1.

Physical habitat variables were standardized and measured at least once since 1984 in each established density monitoring section and in most other sections used in habitat project evaluations. The physical habitat variables other than width and length were not measured every year in each section due to time constraints (parr densities in all sections need to be sampled within a two-month period from late June to late August) and because the physical habitat was relatively stable from year to year. The same physical variables were measured in the parallel IDFG-funded monitoring program. IDFG has encouraged other agencies and tribes to incorporate this standardized variable list (Appendix A-2) into their monitoring programs. More intensive physical habitat monitoring for BPA habitat projects in Idaho is carried out by Project 84-24 which incorporates these standardized variables.

Physical habitat variables measured in each section were percent of pool, run, riffle, pocket water, and backwater; percent of substrate surface sand, gravel, rubble, boulder, and bedrock; section length, average width and depth, gradient, and channel type (Rosgen 1985). The techniques used to collect the physical habitat data are described in Petrosky and Holubetz (1988) and Scully et al. (1990). Physical habitat data collected during 1984-1990 were summarized by channel type. This variable simultaneously categorizes several morphological characteristics, and was used as a primary classification to compare composition of habitat types and substrate within and between streams and to investigate chinook and steelhead rearing potential and population response to sedimentation.

The physical habitat database is being used in conjunction with data collected by project implementors to develop the mitigation record for BPA habitat projects. Quantity and quality of habitat added and improved are estimated primarily by project implementors. Actual and potential production of steelhead and chinook parr attributable to each project are estimated using relationships developed from this database.

We classified the monitoring sections according to two major channel types (Rosgen 1985) and compared parr density trends within these channel types. Scully and Petrosky (1991) demonstrated the effect of channel type on both steelhead and chinook parr densities. A comparison of parr densities in B and

Table 2. Number of sections where steelhead and chinook parr were monitored in Idaho by BPA project 83-7 and other management and research programs from 1984 through 1990.

Year	Number of steelhead sections	Number of chinook sections[a]
1984	60	37
1985	184	139
1986	190	156
1987	225	178
1988	225	175
1989	268	216
1990	349	243

[a]Chinook sections are a subset of the steelhead sections.

TABL90

C channels showed that chinook densities were 3.5 times higher in C channels, while steelhead densities were 2-3 times higher in B channels. B channels are confined in valleys or canyons and have high enough gradient that most fine materials are flushed out. A significant part of the substrate composition may be comprised of boulders larger than 30 cm diameter. C channel streams, in contrast, meander through flat alluvial valleys and are characterized by deposition of fine materials and low velocities. Substrate composition in C channels has a high percentage of small materials, sand, and gravel. In unstable watersheds, sand may be the predominant substrate type in C channels. In general, our C channel sections had gradients less than 1.5%, while B channel sections had gradients in excess of 1.5%.

Parr Density Monitoring

In 1984-1990, the BPA general monitoring and intensive monitoring subprojects established a total of 166 monitoring sections to index the annual abundance of steelhead and chinook parr in BPA habitat project streams. Steelhead parr are defined here as age 1+ and age 2+, with respective lengths of 8-15 cm (3.0-5.9 inches) and 15-23 cm (6.0-8.9 inches). The steelhead length-at-age intervals are similar to those defined by Thurow (1987). Chinook parr are age 0+, with lengths less than 10 cm (4 inches). These data, and data from the parallel IDFG-funded monitoring program, were used to index trends in annual abundance, estimate rearing potential in different habitats, and develop relationships between adult escapements and juvenile fish densities. Mitigation benefits are being determined in part from density trends and habitat-fish relationships developed from this database.

Most anadromous fish production streams in Idaho are clear and have low conductivity. In these streams, snorkel counts by trained observers are preferred for efficiency over estimates obtained from electrofishing. Comparisons of snorkel counts and electrofishing estimates in typical Idaho anadromous streams (Petrosky and Holubetz 1987) demonstrated that direct observation is an excellent method of surveying salmon and steelhead parr populations. Hankin and Reeves (1988) presented similar evidence for western Oregon streams. We obtained density estimates by snorkeling in all sections, except those in the highly conductive and slightly turbid Lemhi River, which we electrofished. The field fish population data form we use for snorkeling surveys is presented in Appendix A-3; survey methods were presented in Petrosky and Holubetz (1986).

We snorkeled the monitoring sections with a team of divers working upstream. Crew size ranged from one for small streams to five or more for larger streams. The combined programs monitored sections in 100 streams, representing a variety of stocks, production types, and habitats. Parr densities were compared among all major anadromous fish drainages in Idaho during 1985-1990. We summarized steelhead and chinook parr densities by year and production type (wild or natural). Because of the preference of steelhead for B channels and chinook for C channels, parr density comparisons among drainages incorporated only the preferred channel type for each species. We analyzed A-run and B-run steelhead separately because of large differences in Columbia River harvest rates and escapements between the two runs (TAC 1991).

We also estimated parr density as a percent of carrying capacity (PCC) derived from standardized smolt capacity ratings developed for subbasin planning by the System Planning Group for the Northwest Power Planning Council (NPPC 1986). The parr density database was merged with the NPPC's species presence/absence database using the common variable EPA reach number. The NPPC file rates each EPA reach as being poor, fair, good, or excellent habitat for rearing chinook and steelhead smolts. Respective NPPC smolt densities in number/100 m^2 are 10, 37, 64, and 90 for chinook and 3, 5, 7, and 10 for steelhead. The NPPC smolt density ratings provide a consistent, though subjective, assessment of habitat quality and smolt carrying capacity within Idaho subbasins. Based on parr densities from this project and a 50% parr-to-smolt survival, or less (Kiefer and Forster 1991), we believe that NPPC smolt densities are good approximations for steelhead, but overestimate capacity for chinook in Idaho streams. NPPC steelhead smolt capacity in excellent habitat (10/100 m^2) and 50% parr-to-smolt survival imply a parr density of 20/100 m^2, the same as defined by Petrosky and Holubetz (1988) based on empirical data. NPPC chinook smolt carrying capacity in excellent habitat (90/100 m^2) and 50% parr-to-smolt survival imply a parr density of 180/100 m^2, which is 67% higher than defined by Petrosky and Holubetz (1988) based on empirical data and fry stocking experiments.

We adjusted the NPPC smolt density ratings to parr carrying capacity assuming that excellent steelhead habitat would support 20 parr/100 m^2 and excellent chinook habitat would support 108 parr/100 m^2 (Petrosky and Holubetz 1988). We also assumed the same relative density proportions between the NPPC habitat classes of poor, fair, good, and excellent. Thus, respective parr carrying capacity ratings for the four habitat classes were: 6, 10, 14, and 20/100 m^2 for steelhead; and 12, 44, 77, and 108/100 m^2 for chinook.

Excellent habitat for chinook would be undisturbed C channel streams, and good habitat would be in undisturbed B channels with moderate gradients. High gradient undisturbed B channels would rate as fair or poor for chinook (Petrosky and Holubetz 1998). For steelhead, excellent habitat would be in undisturbed B channels, and good habitat would be in undisturbed C channels. C channels in productive spring-fed streams could also be classified as excellent steelhead rearing habitat. Degraded streams received ratings of fair and poor for both species depending on the degree of disturbance and channel type. Because the different habitat types and quality ratings are considered in the carrying capacity rating system, both B and C channel sections are analyzed for both species, unlike the analysis for the parr density statistic.

Parr Density Comparisons

We compared steelhead and chinook parr densities and PCC among classes and years for 1985-1990. Steelhead classes were wild A-run, wild B-run, natural A-run, and natural B-run. Chinook classes were wild and natural.

Wild (indigenous) steelhead populations in Idaho presently occur in the lower tributaries (below the mouth of the North Fork) and Selway River of the Clearwater River drainage; in most small Snake River tributaries and in most small mainstem Salmon River tributaries downstream from the mouth of the Middle Fork Salmon River, and in the entire Middle Fork and South Fork Salmon rivers and in Rapid River, tributary to the Little Salmon River (Figure 2). Areas not listed above were considered in this analysis to have natural (hatchery-influenced) populations.

Wild chinook populations in Idaho presently occur throughout the Middle Fork Salmon River drainage and the Secesh River, as well as in several small Salmon River tributaries (Figure 3). The remainder of Idaho's chinook waters were classified as natural populations in this analysis. Because sample size was small for summer chinook, we combined spring and summer chinook and compared only wild and natural classes.

For steelhead, the statistic PCC used the density of age 1+ and age 2+ steelhead parr relative to maximum density that could occur in the section. The PCC statistic may be most appropriate for comparing relative status of populations because it incorporates an estimate of the carrying capacity. Differences in channel type, gradient, stream size, and sediment level are accounted for, in part, by the rating. Because the PCC for steelhead includes both age 1+ and age 2+ parr, it may mask annual differences resulting from adult escapement from two brood years.

The best index of steelhead escapement is probably the age 1+ parr density in B channels. In underseeded conditions as occur in most of Idaho's anadromous fish waters, there is sufficient B channel habitat to support the age 1+ steelhead parr and few are forced into the less desirable C channel habitat. Also, unlike age 2+ parr, none of the age 1+ cohort would have previously smolted.

For chinook, both parr density and PCC are for a single age'class (age 0+) and brood year. Thus, the best overall index may be PCC rather than density in C channels because PCC has a larger sample size, incorporating both B and C channel sections. At extremely low escapements, relatively fewer chinook parr and a smaller PCC would be expected in the less preferred B channel habitat.

The appropriate model to test for effects of class and year, for monitoring data in fixed sections, is a one-way analysis of variance with repeated measures on years. We have been unable to run the repeated measures to date because SYSTAT (Wilkinson 1988) deletes all data from observations from sections with missing values. Scully and Petrosky (1991) approximated the effects of class and year with a two-factor analysis of variance for 1985-89 parr density monitoring data. Future analyses will require development of a statistical method to approximate the missing values for use in the repeated measures model. If missing data is determined to be in patterns, stepdown procedures (variation of MANOVA) will be used. If missing data is random and not excessive, the EM algorithm (Expectation Maximization) will be used (K. Steinhorst, University of Idaho, personal communication).

Anadromous Fish Introductions

The 1984-1989 chinook and steelhead releases into BPA project and monitoring streams are summarized in Scully and Petrosky (1991). No chinook fry were stocked by this project in 1990 due to poor adult escapement in 1989. The new supplementation research project (89-098) will evaluate future hatchery chinook introductions.

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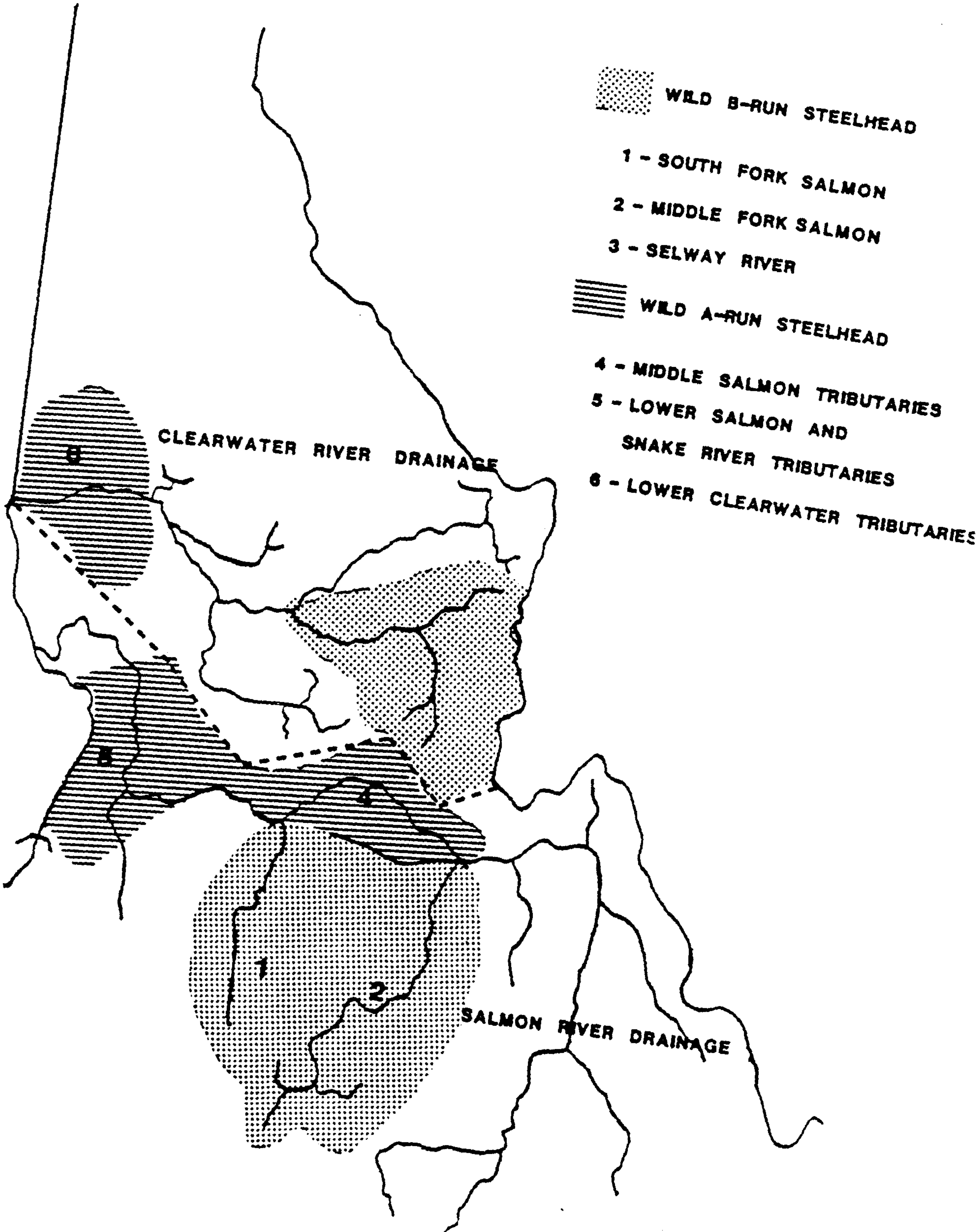


Figure 2. Present distribution of wild A-run and B-run steelhead production areas in Idaho.

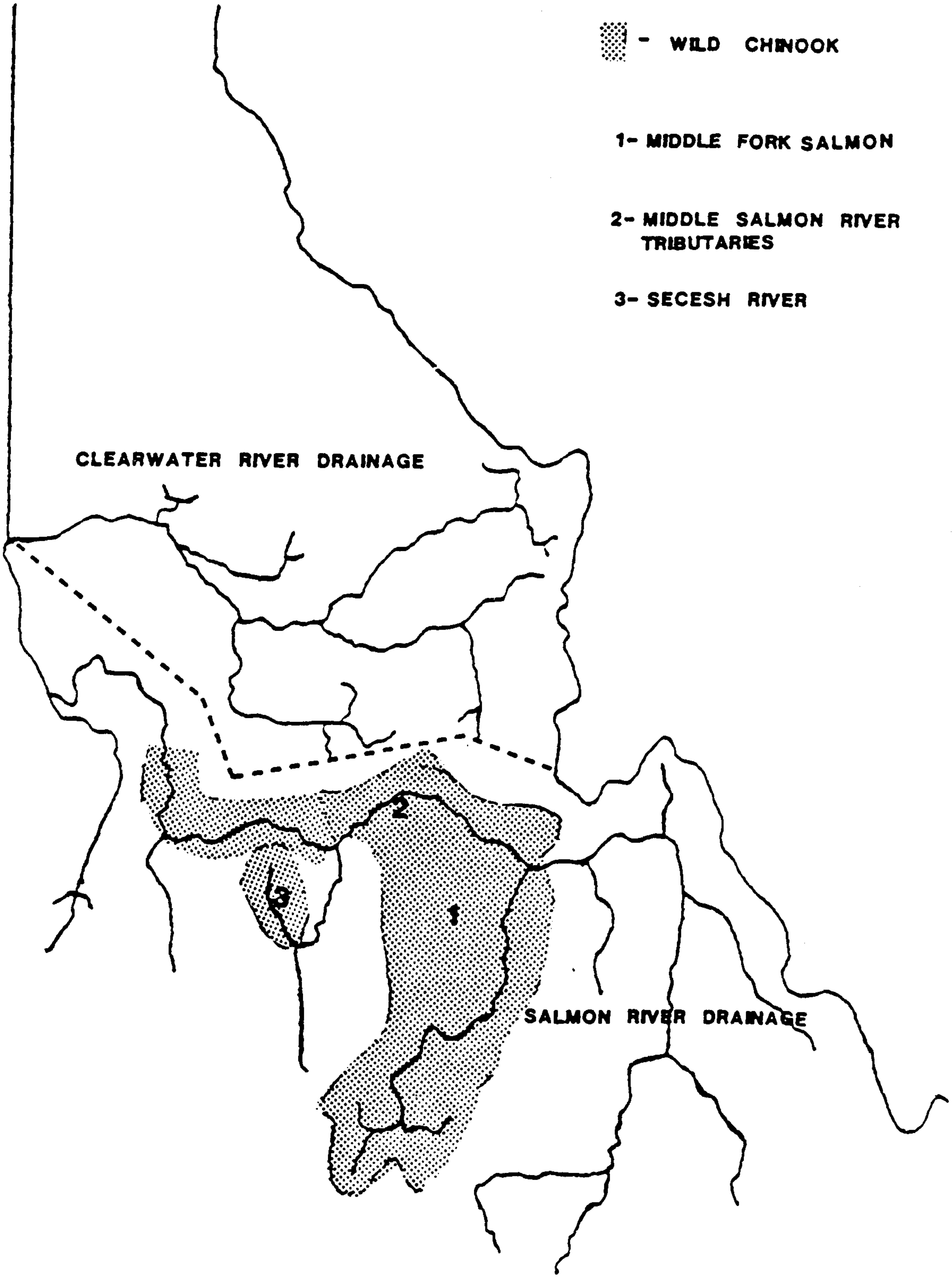


Figure 3. Present distribution of wild chinook production areas in Idaho.

Chinook Reproduction Curves

Columbia River Basin system planning documents (NPPC 1986) assume smolt carrying capacity of rearing habitat to be a density-dependent relationship in the form of a Beverton-Holt function (Ricker 1975). As redd densities increase, smolt (or parr) densities increase to an asymptote (carrying capacity).

Scully and Petrosky (1991) compared densities of age-0+ chinook from Salmon River streams to densities of redds in IDFG spawning ground survey reaches. The data set included only a few observations that approached carrying capacity. Because 1989 redd densities and resultant 1990 parr densities were low, these data contributed little to further development of this relationship.

Steelhead Reproduction Curves

Development of steelhead reproduction curves comparable to those for chinook has been impossible due to lack of established steelhead redd counts in Idaho. In 1990, Project 83-7 personnel conducted single peak redd counts in several Clearwater and Salmon River streams to relate 1991 yearling parr densities to indexed escapements. Primary objectives are to determine: 1) if redd counts correlate to known numbers of spawners; 2) if single peak counts are sufficient to index spawning escapement; 3) if parr densities correlate to redd densities; 4) if accurate redd counts could be made in most years; and 5) in how many years and under what conditions can we expect to miss counts.

Oregon Department of Fish and Wildlife (ODFW) has conducted steelhead redd counts in Northeast Oregon streams since the 1960s, but does not have a parr density monitoring program comparable to that of IDFG. In 1990, Project 83-7 personnel coordinated with Ken Witty of ODFW to collect parr density data in Oregon streams with varying levels of steelhead redd density. ODFW and IDFG personnel jointly sampled parr with backpack electrofishers on June 26-28 1990. Stream sections ranged from 94 to 105 m in length. Age 1+ parr were defined by length-frequency analysis to be from 60 to 159 mm total length. We correlated 1990 yearling steelhead parr density with 1989 redds/mile indices for the Oregon streams.

Chinook Egg-to-Parr Survival

Fry Stocking

Scully and Petrosky (1991) summarized estimated egg-to-parr survival rates for 1985-89 introductions of hatchery chinook fry into project streams. No additional stocking was done in 1990.

Adult chinook returned in 1989 to upper Johnson Creek above the barrier removal as a probable result of fry introduction in 1985-87. Progeny from these returns were monitored in 1990 (see Wild/Natural Spawning below).

Wild/Natural Spawning

Scully and Petrosky (1991) summarized egg-to-parr survival rates of wild and natural spring chinook populations by surface sand classes based on 1984-89 data from the general monitoring subproject and Project 83-359.

In 1990, we used systematic stratified sampling to estimate the abundance of chinook parr above the Johnson Creek barrier removals, which likely were progeny of adults that returned as a result of the 1985-87 fry plants. We estimated egg-to-parr survival based on the 1989 redd count (15), mean fecundity (3,590) of South Fork Salmon River summer chinook (S. Kiefer, Idaho Department of Fish and Game, Subbasin Planning data), and an assumed 1.0 redds/female (R. Kiefer, Idaho Department of Fish and Game, personal communication).

We compared estimated survival in Johnson Creek of chinook from probable hatchery origin to previous survival estimates of wild spawners.

Steelhead Egg-to-Parr Survival

Evaluations of steelhead fry plants comparable to those for chinook are lacking, due in part to the more complex life cycle of steelhead and recent funding priorities on chinook.

Steelhead egg-to-parr survival estimates are generally lacking for Idaho streams due to lack of steelhead escapement data. However, Rapid River wild A-run steelhead are counted annually at the Rapid River Hatchery spring chinook weir. We estimated egg deposition for Brood Year 1989 based on adult length frequency and subbasin planning fecundity data for Snake River A-run steelhead (4,344 and 6,313 eggs per female for ocean age 1 and 2, respectively).

In 1990, we estimated total abundance of yearling and older steelhead parr (partitioned based on length-frequency analysis of Thurow 1987) in Rapid River using systematic stratified sampling. Egg-to-parr survival was estimated to the yearling stage, based on a total abundance estimate and length-frequency analysis.

Partial Project Benefits

Partial project benefits were estimated from 1985 through 1989 according to the project-specific approaches in Petrosky and Holubetz (1986) and reported by Scully and Petrosky (1991). Partial project benefits for 1990 and 1991 will be reported in the 1991 annual report for this project.

Four general types of habitat improvement projects have been evaluated: barrier removals, off-channel developments, instream structures, riparian revegetation, and sediment reduction. Barrier removals and off-channel developments were evaluated by estimating the population of affected anadromous salmonids which reared upstream of the barrier removal site or within the off-channel developments. Total abundance was estimated by stratified random or systematic sampling (Cochran 1965). In years when total abundance was not estimated directly, densities in the affected areas were monitored at one or more snorkeling sections per project, and monitored densities were expanded to population estimates using procedures described in Scully and Petrosky (1991).

Barrier Removals

In 1990, we estimated total abundance of chinook parr in Johnson Creek above the barrier removal project. These parr were likely progeny from outplanted hatchery fry introduced in 1985-87, since the falls had been nearly complete barriers before the project, and the pre-existing spawning area was 15 km downstream.

Instream Structures

During 1983 and 1984, Clearwater and Nez Perce National Forest personnel began placing structures in Crooked River, Red River, and Lolo Creek to improve habitat that was degraded from mining, logging, and grazing activities. During the five years following these structure placements, the IDFG monitored control and treated stream sections to evaluate project benefits in terms of increased parr densities.

In some years and streams, a larger number of replicate sections were sampled to analyze responses of parr densities to instream structures within a given year (Petrosky and Holubetz 1985, 1986, 1987). Scully and Petrosky (1991) analyzed, with repeated measures of analyses of variance, monitoring data replicated annually from 1985 through 1988 from control and treatment sections in two strata (stream reaches) each from Crooked River, Lolo Creek, and Red River.

In 1990, we compared densities in sections treated and not treated with instream structures in Lolo Creek and Crooked River. We selected treatment and control sections in close proximity and increased sample size (Lolo Creek, 24 treatment and 8 control sections; Crooked River, 13 treatment-control pairs of sections) to reduce variance and increase the power of the tests to detect differences.

Riparian Revegetation and Sediment Reduction

In 1987, the Boise National Forest began a project (84-24) to reduce sediment recruitment and revegetate the riparian zone of Bear Valley/Elk Creek in conjunction with improved grazing management (Andrews and Everson 1988). Degradation from cattle grazing is the primary habitat problem in this drainage (0EA 1987). The restoration is expected to be slow and hinges on achievement of improved grazing management. We are evaluating the success of this work, in part, in terms of increased parr density in this drainage relative to densities in control drainages. Concurrently, Project 84-24 has monitored aquatic habitat and riparian conditions both pre- and post-implementation (Andrews, in press).

Benefits from sediment reduction/riparian revegetation projects will be analyzed after completed projects have matured and the physical habitat has responded to the changes. Pretreatment data document the low parr density and low egg-to-parr survival in heavily sedimented streams when compared to pristine control streams in the same drainage. When parr density and egg-to-parr survival improve in response to the projects, comparisons will be made to determine if significant improvements have occurred in the ratio of parr density in sedimented streams to control streams and in the egg-to-parr survival of treated streams. Because of the time lag between treatment and habitat response, analyses to date are limited to comparisons between streams with different sediment levels.

In 1990, we also increased sampling effort for the Camas Creek project to document pre-response densities inside and outside the exclosure.

Database Management and Statistical Analyses

All biological and physical data from 1984 through 1990 were entered into dBase III+ files for easy access and arrangement for various analyses. These files are available for use by project implementors, Tribes, and natural resource agencies upon request.

Summary statistics, analysis of variance, and regressions were done with the statistical software SYSTAT (Wilkinson 1988). Statistical differences were considered significant at probabilities less than 0.10.

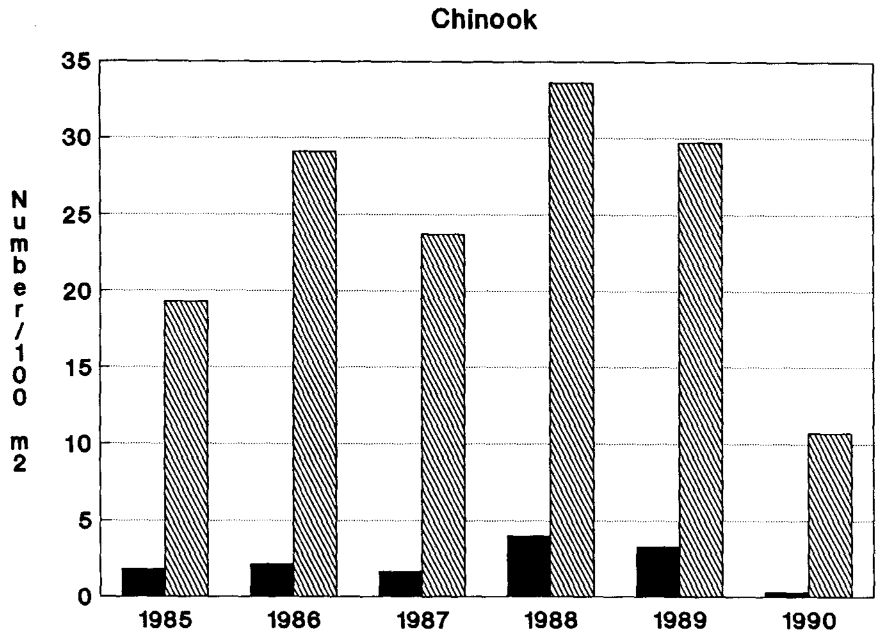
RESULTS AND DISCUSSION

Substrate Sand and Wild Parr Densities

From 1985 through 1990, we monitored chinook and steelhead parr densities in ten sections of the heavily sedimented Bear Valley/Elk Creek (BVC/EC) drainage of the Middle Fork Salmon River and in seven control stream sections of the Middle Fork Salmon River drainage. The controls were similar to the BVC/EC sections in terms of channel type (C) and wild fish management, but the control drainages were the only ones not grazed by cattle. Chinook and steelhead parr densities averaged 10 and 20 times higher, respectively, in the control sections than in BVC/EC sections (Figure 4). The differences were *significant* (p(0.001) for each species. Surface substrate sand in the BVC/EC and control sections averaged 46% and 20%, respectively (Appendix A-4).

Chinook and steelhead parr densities declined in 1990 in both the BVC/EC and control sections (Figure 4).

According to the IDFG Five-Year Anadromous Fish Management Plan, 1992-96 (IDFG in press) the priority for the habitat program is to obtain suitable mainstem Snake and Columbia River hydroelectric project velocity conditions for juvenile salmon and steelhead migration. Improved migration velocities are a prerequisite for success of habitat restoration projects, because mainstem survival is the bottleneck for survival. Exceptions include areas where fine sediment also limits egg-to-smolt survival, such as the South Fork Salmon River and the BVC/EC drainage. In these areas, restoring critical habitat that limits early life history survival is also a priority.



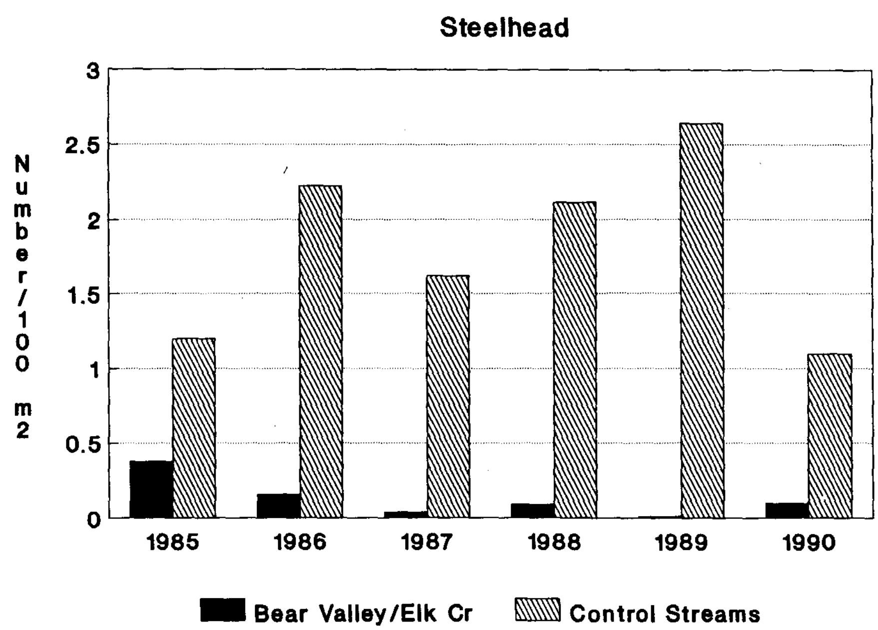


Figure 4. Average annual densities of chinook and steelhead parr in the heavily-sedimented Bear Valley/Elk Creek drainage and Middle Fork Salmon River control streams.

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Parr Density Monitoring

Steelhead Parr

The lowest mean density for age 1+ steelhead parr in 1990 was for natural A-run in the Upper Salmon River (cell 8), 1.0/100 m^2 and wild B-run production areas of the Middle Fork Salmon River (cell 2) and South Fork Salmon River (cell 3), both of which had age 1+ parr densities of 1.0/100 m^2 (Table 3). The highest mean density was for wild A-run in the Snake River (cell 12), 9.4/100 m^2. Of the natural steelhead cells, the highest densities were in the very lightly supplemented Snake River tributaries (natural A-run) (cell 10), 6.8/100 m and **Lochsa** River **(natural B-run)** (cell 4), 9.1/100 m^2.

Percent Carrying Capacity-Parr monitoring in 1985-90 demonstrated depressed levels of some steelhead populations. Wild A-run steelhead density in 1990 averaged 67% of rated carrying capacity, whereas wild B-run averaged 16% (Figure 5, Table 4). Natural (hatchery-influenced) A-run and B-run steelhead PCC were intermediate to those of wild A and B-runs.

In general, 1990 steelhead PCC was similar to previous years with two exceptions. The addition of monitoring sections in the lower Selway and lower Lochsa rivers influenced the means for those cells. Steelhead PCC in the recently added monitoring streams (Fire, Split, and Gedney Creeks) averaged higher than in established areas. Statistical comparisons of annual and run type differences in PCC will be made after we resolve the problem with missing observations in SYSTAT repeated measures models.

Age 1+ Density in B Channels-Comparisons among run types and years of age 1+ steelhead parr densities in preferred B channel habitats were similar to those reported for PCC. Wild A-run and wild B-run densities show the greatest separation, with mean annual densities of wild A-run steelhead consistently four to eight times higher than densities of wild B's (Figure 6, Table 4).

Chinook Parr

In 1990, wild and natural chinook densities were extremely low in all areas except for Chamberlain Basin, where only two C channel sections were sampled (Table 5). Highest densities of natural chinook occurred in the South Fork Clearwater River cell (12).

Percent Carrying Capacity-Parr monitoring in 1985-90 demonstrated depressed levels of chinook populations. In 1990, wild spring and summer chinook density averaged 5% of the rated carrying capacity. Natural spring and summer chinook PCC averaged 6%.

Table 3. Average percent carrying capacity (PCC) for ages 1+ and 2+ steelhead in all monitoring sections and densities (number/100 m^2) of age 1+ steelhead parr in B channels, 1990.

Class, Cell	Avg. PCC	Avg. (n)	Age 1+ density in B channels (n)	
Wild B-run				
1. Selway River	40	(43)	3.2	(22)
2. Middle Fork Salmon River	5	(68)	1.0	(27)
3. South Fork Salmon River	8	(26)	1.0	(13)
Natural B-run				
4. Lochsa River	64	(31)	9.1	(30)
5. South Fork Clearwater River	20	(55)	2.7	(23)
6. Lolo Creek	37	(19)	3.5	(10)
Natural A-run				
7. Little Salmon River, Hazard Cr., Slate Creek and the East Fork Salmon River (A-run streams with B-run or A- and B-run supplementation histories)	31	(15	5.0	(14)
8. Upper Salmon River	8	(54	1.0	(25)
9. Eastern Salmon River tributaries (Pahsimeroi, Lemhi and North Fork Salmon rivers)	32	(17	4.9	(7)
10. Snake River tributaries of Captain John and Granite creeks; and the Little Salmon River tributary of Boulder Creek.	45	(	6.8	(5)
Wild A-run				
11. Middle Salmon River tributaries of Bargamin, Sheep, Chamberlain and Horse creeks.	47	(4)	6.1	(2)
12. Snake River tributaries of Sheep and Wolf creeks; lower Clearwater River tributary of Big Canyon Creek lower Salmon River tributary of Whitebird Creek; and the Little Salmon R. tributary, Rapid River.	77	(8)	9.4	(8)

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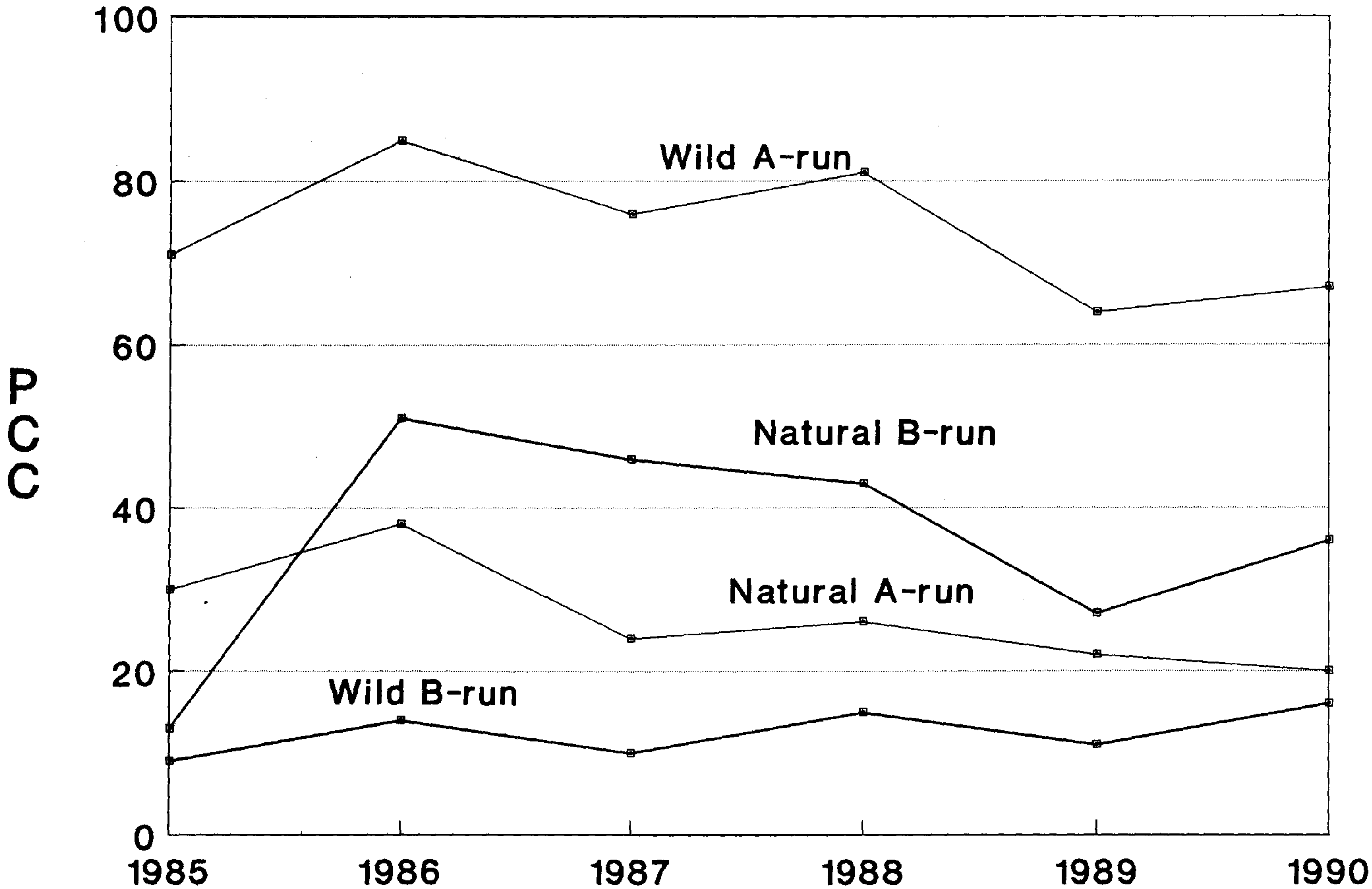

Figure 5. Mean annual percent of carrying capacity of four classes of steelhead parr (age 1+ and 2+) in Idaho, 1985-90.

Table 4. Mean percent of rated carrying capacity (PCC) of age 1+ and age 2+ steelhead parr, and density of age 1+ steelhead parr in B channels, by class and year, 1985-90.

Summary	Class	1985	1986	1987	1988	1989	1990	Mean	SD
PCC	WA	71	85	76	81	64	67	74.0	7.4
	wB	9	14	10	15	11	16	12.5	2.6
	NA	30	38	24	26	22	20	26.7	6.0
	NB	13	51	46	43	27	36	36.0	12.8
B-channel Density	WA	5.9	9.7	7.9	10.3	8.4	8.8	8.5	1.4
	wB	1.7	2.1	1.2	2.2	1.7	1.7	1.8	0.3
	NA	4.6	7.2	2.7	4.8	3.2	3.2	4.3	1.5
	NB	0.9	5.7	4.6	6.1	3.2	5.9	4.4	1.9

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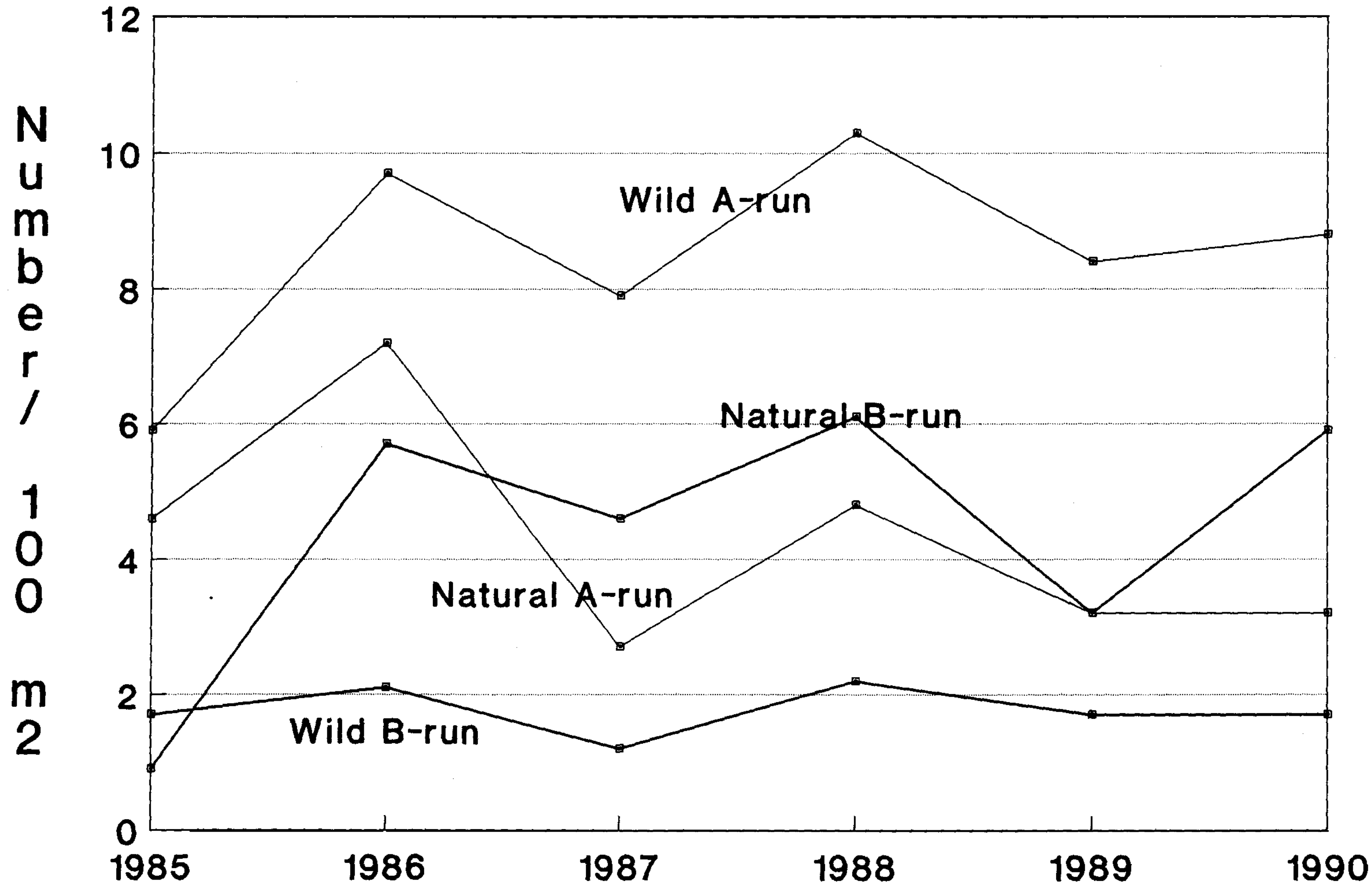

Figure 6. Mean annual density (number of age 1+ steelhead/100 m^2) of four classes of steelhead parr in Idaho, 1985-90.

Table 5. Percent carrying capacity (PCC) for chinook parr in all monitoring sections and density (number of fish/100 m^2) of chinook parr in C channels, 1990.

Class, Cell	PCC (n)	Age 0+ density in C channels(n)	
Wild (Spring)			
1. Middle Fork Salmon River (Without Bear Valley/Elk Creek)	6 (37)	5.9	(17)
2. Salmon River canyon tributaries (without Chamberlain Basin)	3 (4)	--	(0)
4. Chamberlain Basin	23 (4)	25.1	(2)
5. Bear Valley/Elk Creek	1 (7)	0.3	(16)
Wild (Summer)			
3. Middle Fork Salmon, Secesh and upper Salmon rivers	5 (8)	8.6	(4)
Natural (Spring)			
6. Upper Salmon River	3 (40)	4.0	(20)
7. Pahsimeroi, Lemhi, North Fork Salmon rivers and Panther Creek	1 (7)	0.3	(4)
9. Little Salmon River	15 (8)	--	(0)
10. Selway River	1 (35)	4.9	(2)
11. Lochsa River	3 (14)	--	(0)
12. South Fork Clearwater River	6 (49)	11.0	(14)
13. Lolo Creek	11 (7)	8.8	(1)
Natural (Summer)			
8. South Fork Salmon River	10 (13)	7.1	(4)

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Chinook PCC in 1990 was considerably lower than in 1985-89, reflecting poor escapements in 1989. Mean PCC was higher for natural chinook than for wild chinook in all years 1985-90, due mostly to annual outplants of fry in monitoring streams (Figure 7).

As with steelhead, statistical comparisons of annual and production type differences in PCC will be made following resolution of the problem with missing observations in the repeated measures model. Again, levels shown for natural production areas were **artificially** elevated by annual fry outplants.

Acre 0+ Density in C Channels-Chinook parr densities in preferred habitat (C channels) generally mirrored the PCC estimates for all monitoring sections (Table 6, Figures 7-8).

Chinook parr density in C channels in 1990 averaged 5.1/100 m^2, lower than in any year since monitoring began.

Chinook Reproduction Curves

Scully and Petrosky (1991) developed chinook reproduction curves for Brood Years 1983-88 from Salmon River drainage streams where percent of surface sand was less than 35%. This classification included Sulphur Creek data in the model (33% surface sand), but excluded data from the heavily-sedimented BVC/EC sections (average of 46% surface sand). The relationship was:

Redd density/parr density = 0.103 + 0.010 redd density
$r^2 = 0.337$, $p<0.001$, and $n = 66$

where redd density = redds/hectare and parr density = age 0+ parr/100 m^2.

This equation produced a reproduction curve with an estimated carrying capacity of 85 parr/100 m^2 at a redd density of 60/hectare (Figure 9). This Beverton-Holt carrying capacity estimate was 80% of that determined earlier by fry stocking (Petrosky and Holubetz 1988). However, few of the data points approached a fully-seeded condition, and 1990 parr densities added little to the relationship due to weak Brood Year 1989 escapements.

Steelhead Reproduction Curves

In 1990, we counted steelhead redds by helicopter in 47 stream reaches (Table 7), including the upper Salmon and Crooked rivers (Kiefer and Forster 1991), to correlate redd densities with 1991 yearling parr densities. All streams sampled except the upper Salmon River are classified as B-run. Redd densities were artificially high from dropout below the Sawtooth Hatchery weir and in Crooked River from adult outplants. Also, two reaches of the South Fork Salmon River had high redd densities (52 to 62/mile; 19 to 23/hectare). Redd densities for the remainder ranged from 0 to 21 /mile, or 0 to 11 /hectare in 1990. Aerial and complete ground counts were found infeasible in Rapid River due to steep gradient, the narrow canyon, and overhanging vegetation.

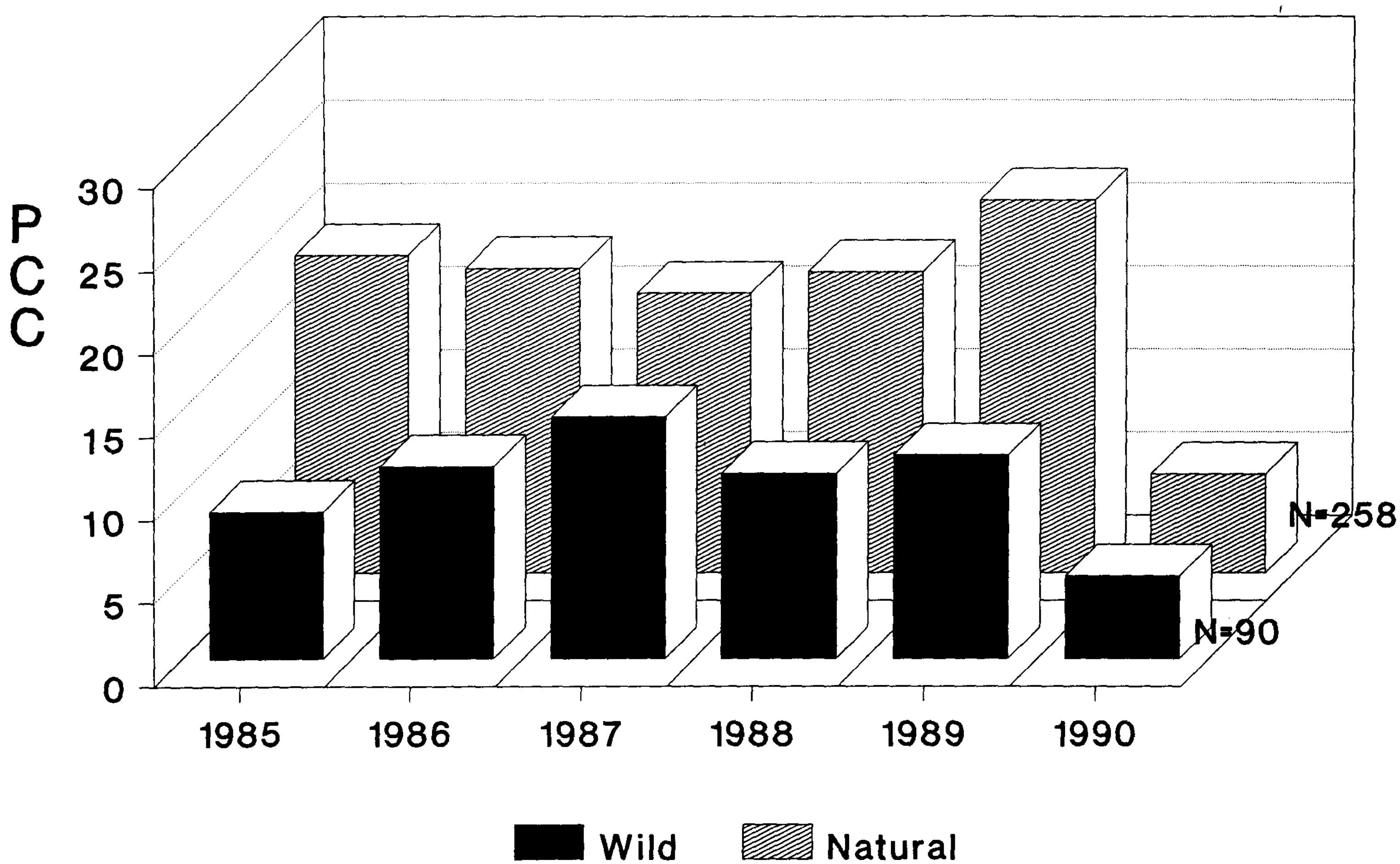

Figure 7. Mean annual percent of carrying capacity of two classes of chinook parr (age 0+) in Idaho, 1985-90.

Table 6. Mean percent of rated carrying capacity (PCC) of age 0+ chinook parr, and density of age 0+ chinook parr in C channels, by class and year, 1985-90.

Summary	Class	1985	1986	1987	1988	1989	1990	Mean	SD
PCC	WSp/WSu	9	12	15	11	12	5	10.7	3.4
	NSp/NSu	19	18	17	17	23	6	16.7	5.7
C-channel Density	WSp/WSu	13.0	15.4	23.9	16.7	13.9	4.9	14.6	6.1
	NSp/NSu	16.2	18.7	21.8	18.5	32.5	6.3	19.0	8.5

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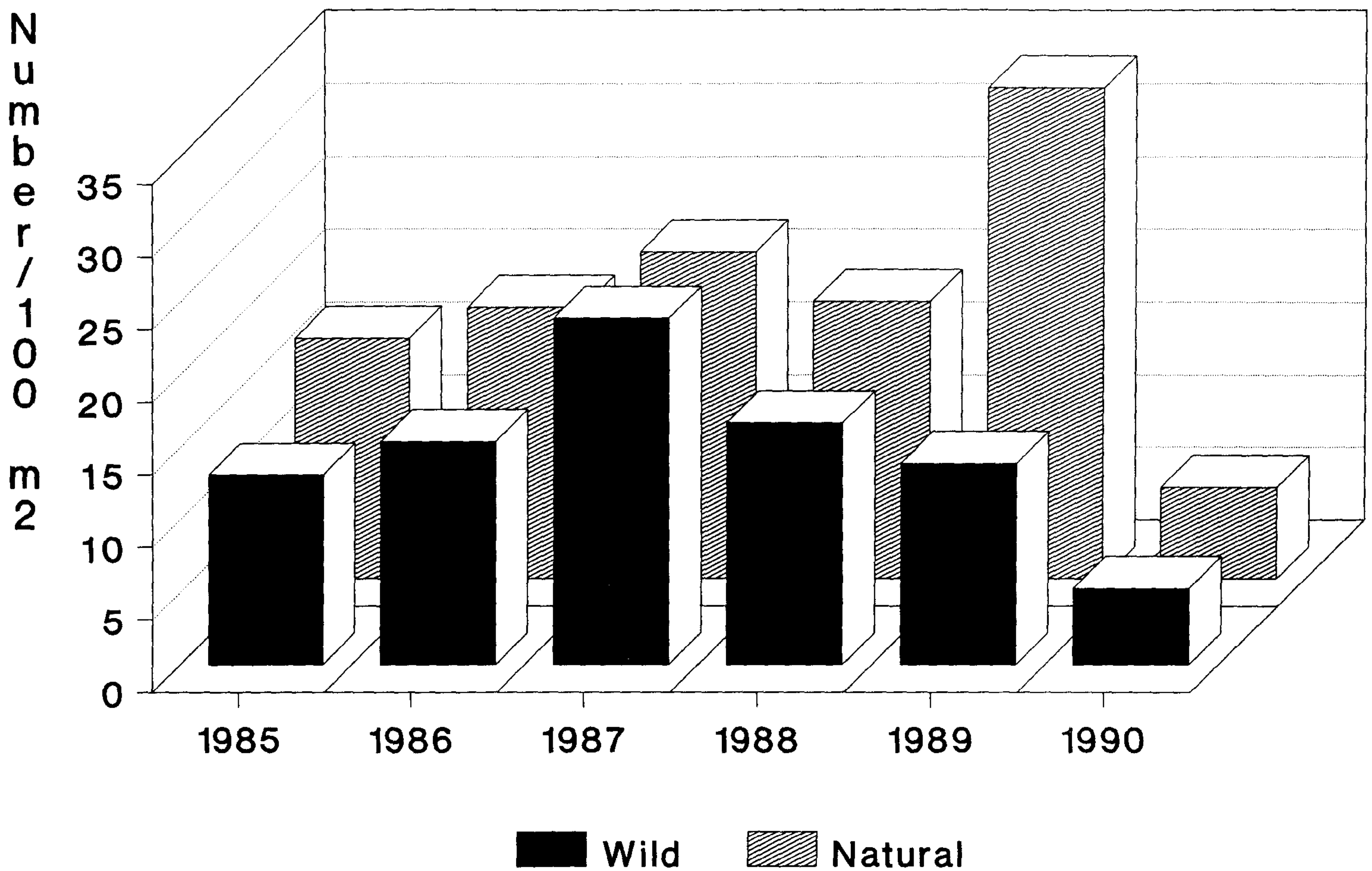

Figure 8. Mean annual density (number/100 m^2) of two classes of chinook parr (age 0+) in Idaho, 1985-90.

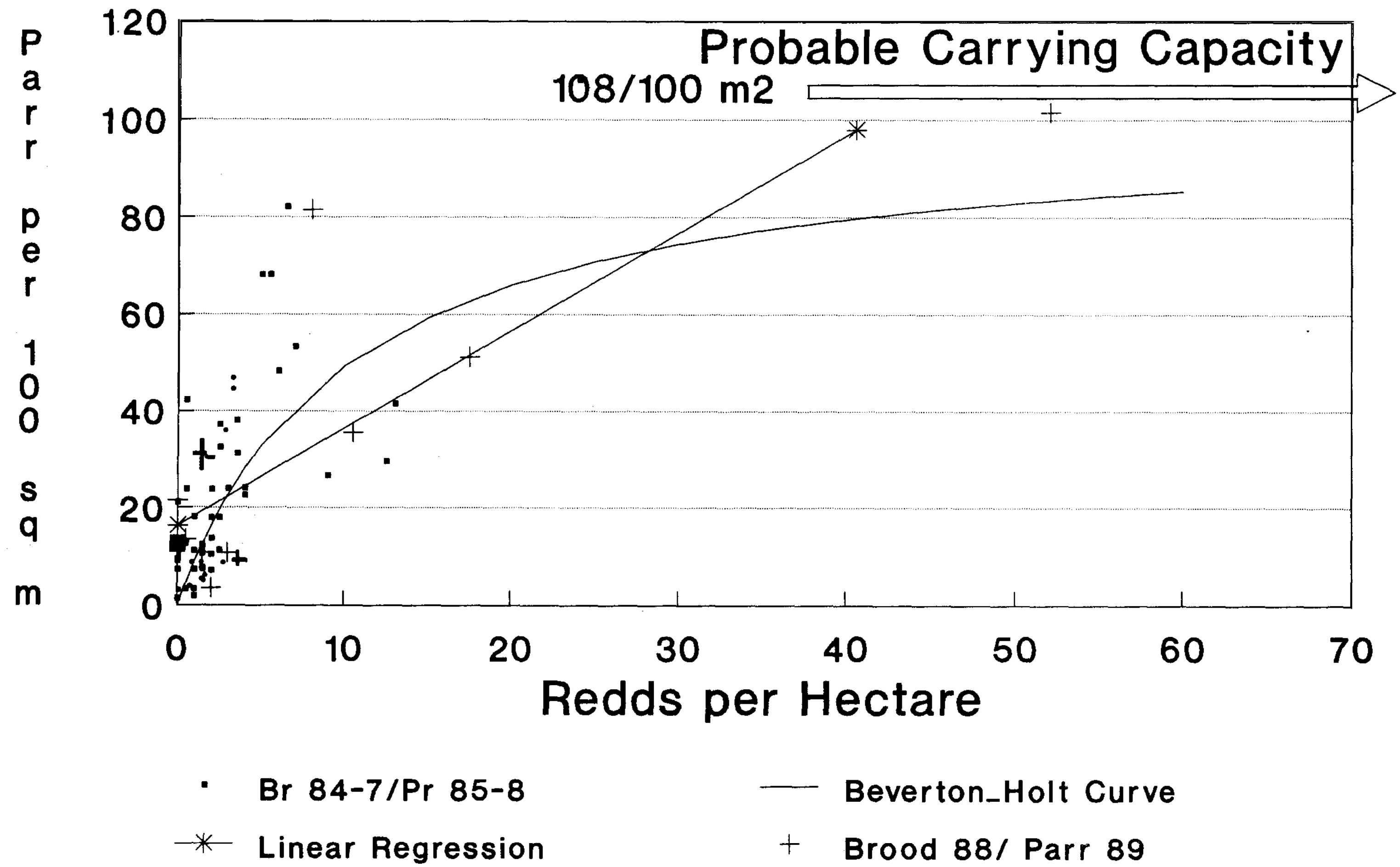

Figure 9. Linear and hyperbolic (Beverton-Holt) regression lines for the density of chinook parr expected as redds/hectare increase. The large arrow represents our best estimate of parr carrying capacity. Scatter points represent redds/hectare:parr/100 m^2 data from upper and Middle Fork Salmon River for brood years 1983-87 for streams with <35% substrate sand. +'s represent the same data for brood year 1988 (Scully and Petrosky 1991).

Table 7. Steelhead redds counted by helicopter in experimental index areas, 1990.

Date	Drainage	Stream	Reach	Miles	Hectares	Redds	Redds/mi	Redds/ha
5/08/90	South Fork Salmon	Salmon R, S Fk	Poverty Flat	1.2	3.20	62	51.7	19.38
		Salmon R, S Fk	Darling Cabin	0.4	1.10	25	62.5	22.73
		Salmon R, S Fk	Oxbow	2.6	6.90	37	14.2	5.36
		Johnson Cr	Ice Hole to Clements	3.5	10.30	23	6.6	2.23
5/08/90	Middle Fork Salmon	Sulphur Cr	Slide to Ranch	1.6	2.75	12	7.5	4.37
		Sulphur Cr	Ranch to Trail	2.1	3.60	2	1.0	0.55
		Bear Valley Cr	Fir Cr bridge to Poker bridge	2.5	8.46	30	12.0	3.55
		Bear Valley Cr	Poker bridge to Elk Cr	3.1	10.19	32	10.3	3.14
		Marsh Cr	Capehorn bridge to Knapp Cr	2.1	2.06	23	11.0	11.17
		Loon Cr	Falconberry to Rock Cr	3.4	6.67	38	11.2	5.70
		Camas Cr, W Fk	Mouth to Flume Cr	1.8	1.32	6	3.3	4.53
		Camas Cr	W Fk to Duck Cr	1.5	4.05	31	20.7	7.66
		Camas Cr	Duck Cr to Furnace Cr	5.8	9.96	24	4.1	2.41
		Big Cr	Cougar Cr to Rush Cr	2.3	6.77	21	9.1	3.10
		Big Cr	Cabin Cr to Cave Cr	1.1	3.24	23	20.9	7.11
5/08790	Upper Salmon R	Valley Cr	Forks to Stanley Cr bridge	4.5	4.41	2	0.4	0.45
		Valley Cr	Stanley Cr bridge to Mouth	5.6	13.73	8	1.4	0.58
		Upper Salmon R	Redfish L Cr to weir	1.7	6.75	101	59.4	14.96
		Upper Salmon R	Weir to Hell Roaring Cr	10.3	40.92	33	3.2	0.81
		Upper Salmon R	Hell Roaring Cr to Alturas L Cr	5.8	23.04	16	2.8	0.69
		Upper Salmon R	Alturas L Cr to Busterback diversion	4.6	6.77	1	0.2	0.15
		Upper Salmon R	Busterback diversion to Hwy 93 bridge	7.7	9.44	6	0.8	0.64
		Alturas L Cr	Mouth to bridge	1.8	4.24	6	3.3	1.42
		Salmon R, E Fk	Germania Cr to weir	5.3	11.70	9	1.7	0.77
5/08/90	Salmon Canyon	Chamberlain Cr	Flossie Cr to W Fk	2.5	2.94	6	2.4	2.04
		Chamberlain Cr, W Fk	Mouth to Game Cr	2.6	2.04	5	1.9	2.45
5/13/90	S Fk Clearwater	Crooked R	Canyon to bridge	2.3	3.72	128	55.7	34.39
		Crooked R	Bridge to Orogrande	3.0	4.86	91	30.3	18.74
		Red R	S Fk to Schissler bridge	9.3	13.10	2	0.2	0.15
5/13/90	Selway	Running Cr	Roaded area	0.4	0.60	0	0.0	0.00
		Running Cr	Mouth to Eagle Cr	2.1	3.40	0	0.0	0.00
		Eagle Cr	Mouth to Forks	2.1	0.80	0	0.0	0.00
		Selway R	Magruder Crossing to Little Clearwater	2.1	5.97	1	0.5	0.17
		Whitecap Cr	1 mile upstream of Canyon Cr	1.0	1.96	1	1.0	0.51
		Whitecap Cr	2 miles downstream of Canyon Cr	2.0	5.89	3	1.5	0.51
		Bear Cr	Mouth to Cub Cr	5.5	15.11	9	1.6	0.60
		Bear Cr	Cub Cr to Swamp Cr	5.3	10.40	6	1.1	0.58

TAB7

Table 7. Continued.

Date	Drainage	Stream	Reach	Mile	Hectar	Redd	Redds/mi	
5/13/90	Lochsa	Lochsa R	Slide to weir	na	na	5	na	na
		Crooked Fork Cr	Mouth to Hwy 12 bridge	6.8	20.01	15	2.2	0.75
		Crooked Fork Cr	Hwy 12 bridge to Shotgun Cr	5.0	14.22	18	3.6	1.27
		Whitesand Cr	Mouth to Storm Cr	12.3	60.32	2	0.2	0.03
		Whitesand Cr	Big Flat Cr to Heater Cr	3.8	6.15	10	2.6	1.63
		Storm Cr	0.5 mi below Maud Cr upstream to rock	5.1	2.50	11	2.2	4.40
		Fish Cr	Pagoda Cr to Hungry Cr	2.0	3.24	6	3.0	1.85
		Fish Cr	Hungry Cr to Ash Cr	9.1	14.73	3	0.3	0.20
		Hungry Cr	Mouth to Doubt Cr	1.4	1.72	2	1.4	1.17
5/13/90	Main Clearwater	Lolo Cr	1 mi above Musselshell to Bradford	2.1	3.60	6	2.9	1.66

Steelhead redd counts in 1989 in the Grande Ronde data set selected by ODFW for comparisons with 1990 yearling densities ranged from 7.1 to 22.0/mile (Table 8). These equate to redd densities of 9 to 28/hectare. The streams were small tributaries to Joseph Creek, at mid-elevation (1,150-1,475 ft msl) in a basalt drainage, in contrast to the larger generally high elevation, granitic drainages sampled in Idaho in 1990. Also, Grande Ronde steelhead are A-run, whose 1989 redd densities were reportedly considered by ODFW staff to be close to management objectives (TAC 1991).

Yearling parr densities in the Oregon data set ranged from 3.5 to 29.1/100 m^2 in 1990 (Table 8, Figure 10). These parr densities were similar to those found in most A-run streams in Idaho (excluding the Upper Salmon river). We found a significant relationship between parr density and redd density (ANOVA, $F=29.391$, $p<0.001$). The TAC report (1991) concludes: "These findings indicate that parr density may provide a good index of spawner abundance for populations below carrying capacity. Also, since parr density is non-asymptotic over the range of redd densities measured, it is likely that spawner escapements were not sufficient to fully seed the habitat."

Chinook Eaq-to-Parr Survival

Fry Plant Evaluations

No fry plants were made into project streams in 1990. The mean unweighted survival rate (mid-May to mid-August) for 17 fry plant evaluations in 1986-89 was 18.9% (Scully and Petrosky 1991). A mean green egg-to-fry survival of 75% in Idaho hatcheries implied an egg-to-parr survival of 14.1% for fry plants.

Fry plants in 1985-87 in upper Johnson Creek above the barrier removal project likely resulted in the 15 redds counted in 1989, since chinook spawners were rarely documented in recent times at this site prior to removal of the barrier falls (Petrosky and Holubetz 1986).

Wild/Natural Spawning

Scully and Petrosky (1991) summarized egg-to-parr survival rates of wild and natural spring chinook populations by surface sand classes based on IDFG redd counts and 1984-89 abundance estimates from the general monitoring subproject and Project 83-359 (Figure 11). Estimated survival in highly-sedimented streams (Bear Valley and Elk creeks) was about one-fourth to one-eighth that in streams with moderate to low sediment levels.

Estimated total abundance of chinook parr in upper Johnson Creek in 1990 was 246 $\pm$ 57 (2 SE). Estimated egg-to-parr survival was 0.5%, even lower than estimates from Bear Valley and Elk creeks (Table 9). The poor survival is likely due to relatively high sediment levels and riparian degradation (Andrews and Radko, in press) in upper Johnson Creek and/or reduced viability of hatchery origin fish (Miller et al. 1990). Idaho supplementation research .(Project 89-098) will provide insight into viability of specific hatchery stocks currently

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Table 8. Joseph Creek (Oregon) tributary sections, habitat attributes, redd densities and parr densities (number/100 m^2), June 26-28,

1990.

Class, stream		Width (m)	Channel type	% grad.	Water temp F (time)	Redds per mi	Parr density
High density							
Summit Cr.	1	2.3	B	3.4	54 (1330)	22.0	27.4
	2	2.2	B	4.4	54 (1445)	22.0	29.1
Devil's Run Cr.	1	5.8	B	1.6	62 (1530)	18.2	14.7
	2	4.9	B	2.2	49 (1900)	18.2	9.8
	3	1.8	B			18.2	21.1
Medium density							
Elk Cr.	1					11.2	8.9
	2	2.3	C	1.1	70 (1400)	11.2	9.1
Low density							
Crow Cr.	1	3.9	C		62 (1300)	7.1	6.5
	2	3.2	C	0.6	68 (1730)	7.1	3.5
Pea Vine Cr.	1	5.8	C	--	52 (0915)	7.8	6.4
	2	4.2	C	0.4	58 (0935)	7.8	9.4
	3	5.0	C			7.8	11.3

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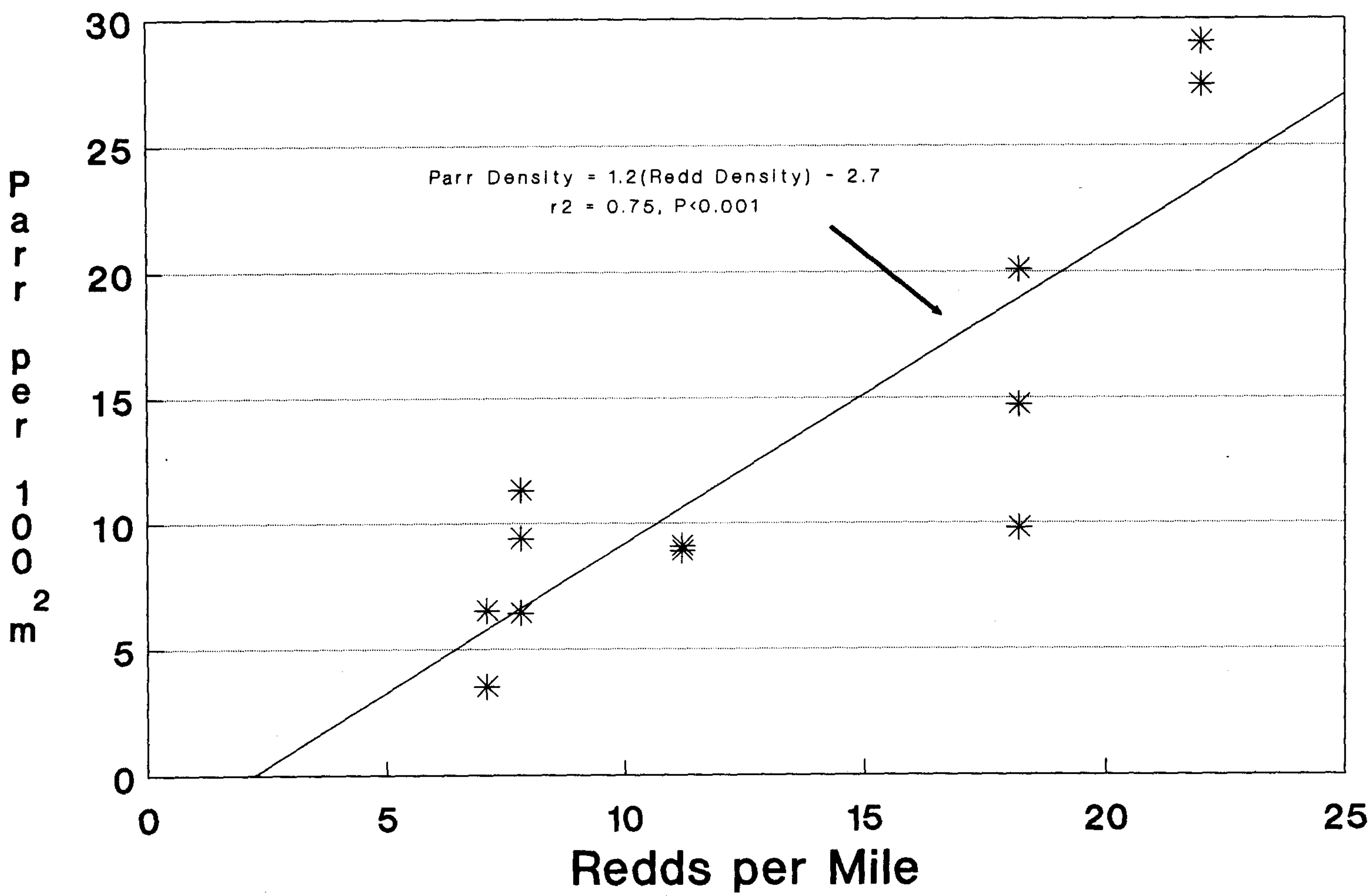

Figure 10. Steelhead age 1+ parr density versus number of redds per mile in Joseph Creek (tributary to the Grande Ronde River) in northeast Oregon, 1990.

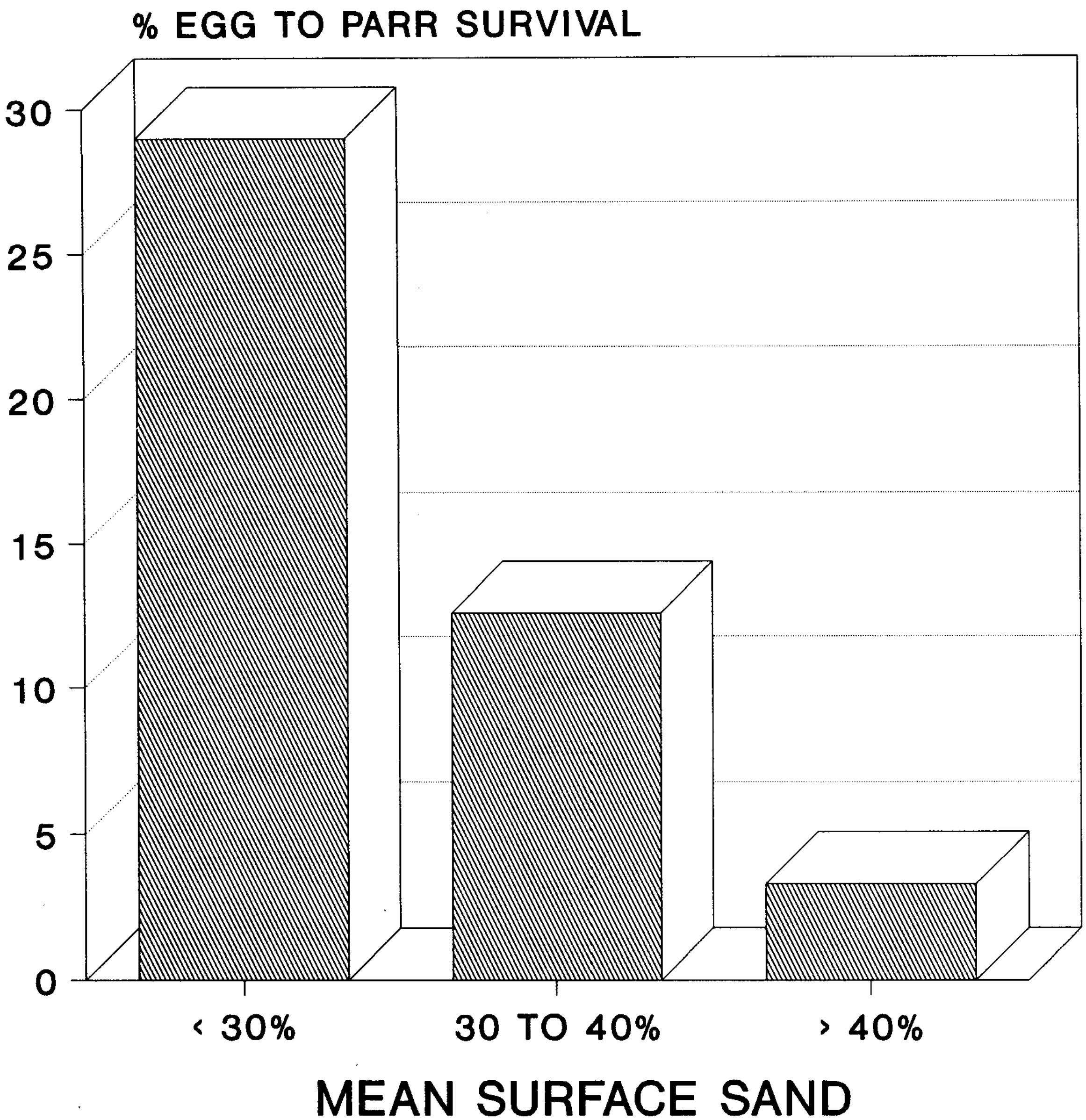

Figure 11. Mean estimated chinook egg-to-parr survival from six streams by sediment class (% surface sand), 1985-89 (Scully and Petrosky 1991).

Table 9. Wild/natural chinook egg to parr survival estimates by % sand categories. The analysis assumes a fecundity of 5,900 eggs/female (Scully and Petrosky 1991).

% surface sand	Stream	Year	% survival 1.5 redds/female	% survival 1.0 redds/female
<30%	Marsh Cr.	1985	32.5	21.7
	Salmon R.	1985	25.5	17.0
			$\bar{x}$ = 29.0	19.4
30-40%	Herd Cr.[a]	1986	13.0	8.7
		1987	13.3	8.9
	Sulphur Cr.	1989	11.6	7.7
			$\bar{x}$ = 12.6	8.4
>40%	Elk Cr.	1985	6.2	4.1
		1986	1.7	1.1
		1987	1.2	0.8
	Bear Valley Cr.[a]	1984	8.2	5.5
		1985	2.2	1.5
		1986	1.2	0.8
		1989	2.1	1.4
			$\bar{x}$ 3.3	2.2
All habitats (Mean of sand category means):			= 15.0%	10.0%
Mean without Bear Valley and Elk Creeks:			= 20.8%	13.9%

[a]Shoshone-Bannock tribe data on parr abundance.

TABL90

used in supplementation. It is important to note that emigration of chinook juveniles further than 5 km up or downstream from the redd deposition area (near the mouth of Whiskey Creek) was not accounted for and may have negatively biased our estimate of egg-to-parr survival.

Steelhead Egg-to-Parr Survival

Wild/Natural Spawning

Estimated 1990 total abundance of steelhead parr in Rapid River above the weir was 13,217 ± 201 (Table 10). Yearling steelhead total abundance in 1990 was 7,352 ± 154; therefore, egg-to-yearling parr survival would be 3.1% for Brood Year 1989. Results of future scale analysis for Rapid River steelhead may modify this estimate.

We believe that the 1989 escapement did not fully seed Rapid River in 1990. The 1990 parr density in Rapid River (7.8/100 m^2) was only 39% of the rated carrying capacity and generally less than in the 1990 Oregon data set (Table 8). Based on an assumed 1.0 redds/female and 23.2 miles of available habitat, the 1989 escapement would have resulted in an average 3.2 redds/mile, fewer than the Grande Ronde tributaries. Egg deposition in 1989 was 202/100 m^2 in the low range of escapements for Snow Creek, Washington winter steelhead (Johnson 1983).

Future weir studies will help define production functions appropriate to Idaho summer steelhead. Total parr abundance in candidate weir streams (Scully and Petrosky 1991) will be estimated in 1991 to determine a composite parr density range. The weir permitting process will begin in 1992.

1990 Habitat Protect Evaluations

Barrier Removal

Project benefits from the Johnson Creek barrier removal project were evaluated in 1990 with a total abundance estimate of first generation returns from fry outplants in 1985-87 (see Chinook Egg-to-Parr Survival). We attributed as benefits all chinook parr produced above the project (246 ± 57; 2 SE) in 1990.

Instream Structures

We tested 1990 parr densities in sections treated and not treated with instream structures using a randomized complete block ANOVA in Lolo Creek and Crooked River. This sampling suggested modest benefits for spring chinook and steelhead parr due to instream structure projects. However, densities were very low (PCC range, 1 to 23), even where we found significantly higher densities in treated sections.

Table 10. Escapement, egg deposition, total yearling parr abundance and egg-to-yearling survival of wild A-run steelhead, Rapid River, brood year 1989.

Parameter	BY 1989
Male	
1-ocean	23
2-ocean	3
Female	
1-ocean	11
2-ocean	38
Fecundity	
1-ocean	4,344
2-ocean	6,313
Egg Deposition	
Females/mile	2.1
Redds/mile @ 1.0 redds/female	2.1
Total	287,67
Eggs/100 m^2	202.0
Parr abundance (BY+1)	
Age > 1+	13,217
Yearlings	7,352
Yearlings/100 m^2	4.0
Egg-to-yearling survival (%)	2.6

TABL90

Sections of Lolo Creek treated with K dams supported chinook and steelhead parr densities in 1990 that were 47% and 146% higher than controls, respectively (Table 11). These differences were statistically significant only for steelhead ($F=8.61$, $p=0.02$). Sections treated with rock weirs supported significantly higher densities of chinook (163%; $F=5.67$, $p=0.05$) and steelhead (31%; $F=4.90$, $p=0.06$).

Sections of Crooked River treated with instream structures supported chinook parr densities in 1990 that were slightly lower (43%) than controls (Table 12); the difference was not significant. Steelhead parr densities were 27% higher for yearlings and 63% higher for all parr in treatment sections; only the test for all steelhead parr was statistically significant ($F=5.37$, $p=0.04$).

Low densities make a full interpretation difficult, however the data indicate some benefits due to the structures in both streams. The blocked design was more efficient for detecting differences than a complete random ANOVA, and several location (block) differences were significant. For mitigation accounting, we assumed mean density differences were real even when not statistically significant.

Riparian Revegetation/Sediment Reduction

Sampling in 1990 in the Camas Creek project area documented depressed chinook and steelhead parr densities prior to major physical habitat responses. Steelhead parr density in the project reach averaged 1.3/100 m^2 with a mean PCC of 7.0%. Chinook parr density averaged 0.5/100 m^2 with a mean PCC of 1%. J. Andrews (USFS, unpublished data) documented that an increase in willow and cottonwood woody stem regeneration began three years after completion of the exclosure. We expect a 5- to 10-year lag before improvements are evident in instream habitat in the project area.

Partial Project Benefits

The Fish and Wildlife Program has funded habitat enhancement projects in Idaho to increase spawning and rearing potential for steelhead and chinook. Projects include barrier removals, off-channel developments, instream structures, and sediment reduction. Although benefits to date are modest, 14 of the 16 projects evaluated had measurable production that was attributed to the enhancement projects through 1989 (Scully and Petrosky 1991). The subject of Partial Project Benefits was addressed more thoroughly by Scully and Petrosky (1991) than in this text, and will again be addressed in the 1991 annual report.

Barrier removals, followed by instream structures, have had the largest effect on increasing anadromous fish production. Off-channel developments in the form of connected ponds, have very high chinook parr carrying capacity, with observed densities in supplemented ponds in excess of 200/100 m^2. However, the amount of surface area in off-channel developments thus far created has been small and total smolt production benefits slight. The sediment reduction project on the BVC/EC drainage depends on improved grazing management and will not produce full benefits in terms of reduced sediment and increased egg-to-parr

Table 11. Mean density (number/100 m^2) and PCC by age group of steelhead and chinook parr in sections of Lolo Creek that were treated or not treated with instream structures, July 10-11, 1990. F-tests and probability levels reported for individual treatments compared to control. Significant tests denoted with asterisk.

Species, age	Treatment[a] CO, KD, WE	Treatment Density	Treatment PCC	Treatment $F_{1,7}$		Block $F_{7,7}$	p
Chinook 0	CO	3.8	4.9	--	--	--	--
	KD	5.6	7.3	0.91	0.37	1.61	0.27
	WE	10.0	13.0	5.67	0.05*	2.37	0.14
Steelhead 1+	CO	1.3	9.5	--	--	--	--
	KD	3.2	22.7	8.61	0.02*	4.78	0.03*
	WE	1.7	12.3	4.90	0.06*	76.18	0.00*

[a]CO = control, KD = kdams, WE = rock weirs.

TABL90

Table 12. Mean density (number/100 m2) and PCC by age group of steelhead and chinook parr in sections of Crooked River that were treated or not treated with instream structures, July 3-5, 1990.

Species, age	Treatment[a] CO, IS	Treatment Density	Treatment PCC	Treatment $F_{1.7}$	Treatment P	Block $F_{7.7}$	Block P
Chinook 0	CO	1.4	1.8	--	--	--	--
	IS	0.6	0.8	1.28	0.28	1.75	0.17
Steelhead 1+	CO	1.5	10.6	--	--	--	--
	IS	1.9	13.9	2.19	0.16	5.58	0.00*
Steelhead >1+	CO	1.9	13.6	--	--	--	--
	IS	3.1	22.3	5.37	0.04*	3.54	0.02*

[a]CO = control, IS = instream structures (all types).

TABL90

survival for several years. A slight improvement occurred in 1987-90 in the ratio of chinook parr density for BVC/EC:control streams. Since this drainage is large, the small density increase resulted in a relatively large estimated benefit in terms of parr and smolts produced.

Quantification of instream structure benefits has been the most difficult. Monitoring of parr densities in treatment and control sections suggest some project benefits have occurred. More intensive evaluations by this project, including 1990, have detected some significant density increases due to the structures, but the majority of differences were not significant (Petrosky and Holubetz 1985, 1986, and 1987). Clearwater Biostudies, Inc. (1988) found that age 0+ chinook and age 1+ and older steelhead parr were generally more abundant in enhanced than unenhanced habitat in Lolo Creek.

It appears that modest density increases have occurred due to the three instream structure projects. However, it is important to note that it is extremely difficult to differentiate between an increase in actual densities (increased parr production) and mere attraction to instream structures (site specific increased parr concentration). For current mitigation accounting, we have assumed that the density differences are real. These estimates will be revised as necessary based on future evaluations with increased sample size. Scully and Petrosky (1991) estimated benefits as the mean difference in parr density each year between control and treatment sections. The mean differences in parr density were multiplied by the stream surface area in the affected reaches and factored by the estimated parr-to-smolt survival. This approach probably overestimated instream structure benefits, since we have not yet determined the portion of the reaches that were not affected by the structures; i.e., sections which would classify as control areas or sections which already had good habitat and were not considered for treatment. However, the amount of area not treated in the instream structure project reaches is very small relative to the area treated. We will obtain estimates of the treated surface area for future reports.

Instream structure projects in Red River will be evaluated again in 1991. Sampling effort will be increased with the objective of detecting significant differences if parr densities in treated sections exceed those in controls by at least 30%.

Kiefer and Forster (1990) determined average parr-to-smolt survival rates of 39% for chinook and 44% for steelhead for 1988-1990 from the upper Salmon River and Crooked River. During the period when most habitat enhancement projects were mature (1986-89), annual benefits averaged 6,271 steelhead smolts and 55,482 chinook smolts (Scully and Petrosky 1991).

Maximizing benefits from habitat improvement projects depends on adequate mainstem flows and velocities and good passage survival of smolts in the Snake and Columbia rivers. Determination of benefits in terms of adult returns and economic benefits is beyond the scope of Project 83-7, but will be possible based on these parr and smolt estimates and the future System Monitoring and evaluation Program (section 206(d)) data on smolt-to-adult returns to the Columbia River and to Idaho.

Based on recent average return rates of 1.67% for A-run steelhead (unpublished data) and 0.37% for chinook (Petrosky 1991), the estimated smolt benefits would result in adult benefits of 105 steelhead and 205 chinook returning to Idaho for the first generation (Scully and Petrosky 1991). Meyers (1982) assigned respective values of $359 and $550 per adult steelhead and chinook returning to the Columbia River system. Using these values and Idaho returns, the average first generation benefit from the BPA projects implemented in Idaho would be $37,695 for steelhead and $112,750 for chinook. The benefits would increase substantially with time if populations rebuild due to improved flows and passage survival. Conversely, the benefits would be negligible if populations decline as has been the trend since 1988 (TAC 1991). Calculations in Scully and Petrosky (1991) illustrate the range of benefits that could occur depending on passage survival conditions and smolt-to-adult returns.

The number of smolts attributed to the habitat projects to date is small relative to their potential (Figure 12). This is due primarily to chronic poor passage survival and the resulting underescaped depressed populations. It is important to note that the apparently high project benefits for chinook (Figure 12) were due mostly to fry stocking in barrier removal projections.

In BPA habitat improvement project areas, chinook densities averaged 23% of the rated capacity; 15% of the PCC was attributed to the projects (Scully and Petrosky 1991). Project benefits were artificially high for chinook due to fry stocking in many streams, either to establish natural populations or to supplement natural production in the project areas.

Steelhead PCC averaged 19% and chinook PCC averaged 10% in habitat improvement project streams. Most steelhead projects were in B-run production areas or in A-run areas of the upper Salmon River; both areas with extremely depressed populations.

Ninety percent of carrying capacity for chinook and 81% of carrying capacity for steelhead remain unoccupied in the project streams. Stocking has artificially increased the PCC in some project streams, but not to an extent that has overcome the escapement deficit from poor passage survival.

Compared to subbasin planning estimates of natural smolt potential in Idaho of 15.5 million spring/summer chinook and 4.5 million steelhead, the increased production is extremely small. If all Idaho habitat improvement projects identified in subbasin planning were implemented, total smolt potential would increase only 17% for chinook and 9% for steelhead because the productive capacity remains high for the majority of Idaho anadromous fish streams. However, for a limited number of degraded streams, habitat improvement could yield significant benefits if the passage survival problem is solved.

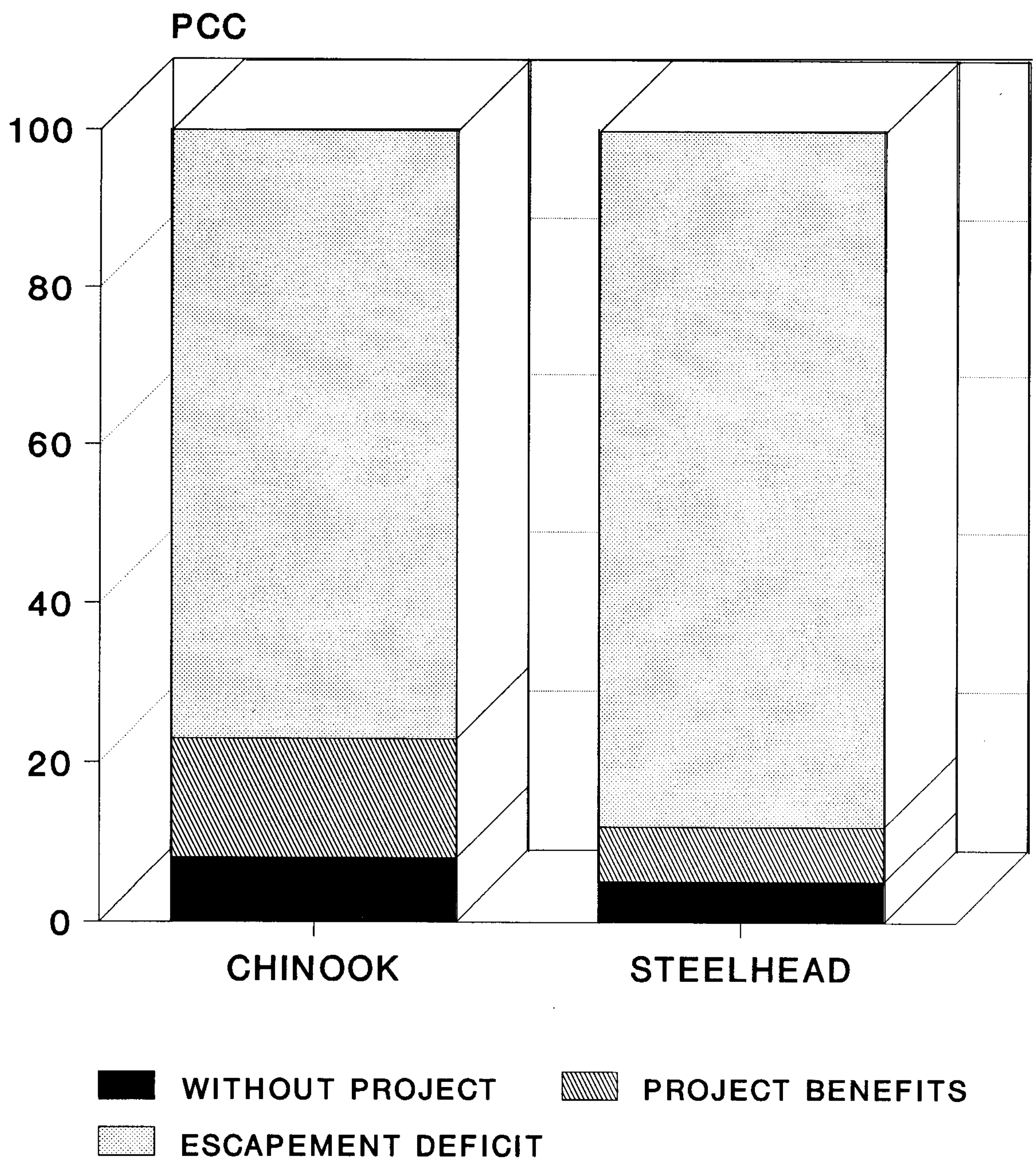

Figure 12. Mean percent of rated carrying capacity for chinook and steelhead parr without habitat projects, project benefits, and unrealized potential due to escapement deficit, in BPA habitat improvement areas, Idaho, 1986-89 (Scully and Petrosky 1991).

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APPENDICES

Appendix A-1. Monitoring section names and EPA stream reach locations, channel types (B or C), steelhead classification (wild or natural, A- or B-run), chinook classification (wild or natural, spring or summer) and if chinook are monitored.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
** Snake R, above mouth Salmon R							
1706010101000	GRANITE CR		1	B	NA	WSPR	N
1706010101000	GRANITE CR		2	B	NA	WSPR	N
1706010101000	GRANITE CR		3	B	NA	WSPR	N
1706010101300	SHEEP CR		1	B	NA	WSPR	N
1706010101300	SHEEP CR		2	B	NA	WSPR	N
** Snake R, below mouth Salmon R							
1706010303900	CAPTAIN JOHN CR		2	B	NA	WSPR	N
1706010303900	CAPTAIN JOHN CR		1	B	NA	WSPR	N
** Upper Salmon R							
1706020107700	ALTURAS LK CR	US-DVRSN	IA	B	NA	NSPR	Y
1706020107700	ALTURAS LK CR	DS-DVRSN	1B	B	NA	NSPR	Y
1706020107700	ALTURAS LK CR	DS-DVRSN	1C	C	NA	NSPR	Y
1706020108100	ALTURAS LK CR	US-LAKE	3A	C	NA	NSPR	N
1706020108100	ALTURAS LK CR	US-LAKE	3B	C	NA	NSPR	N
1706020107700	ALTURAS LK CR	US-DVRSN	2A	B	NA	NSPR	Y
1706020107700	ALTURAS LK CR	US-DVRSN	2B	B	NA	NSPR	Y
1706020114700	BEAVER CR		A	C	NA	NSPR	N
1706020114700	BEAVER CR		B	C	NA	NSPR	Y
1706020114800	FRENCHMAN CR		A	B	NA	NSPR	N
1706020100200	MORGAN CR	LOWER	FENCE	B	NA	NSPR	Y
1706020100200	MORGAN CR	UPPER	BLM-CAMP	C	NA	NSPR	N
1706020114900	POLE CR		A	C	NA	NSPR	N
1706020114900	POLE CR		B	C	NA	NSPR	N
1706020114900	POLE CR	II	A	C	NA	NSPR	N
1706020114900	POLE CR	IV	A	C	NA	NSPR	N
1706020114900	POLE CR	IV	B	B	NA	NSPR	N
1706020114900	POLE CR	V	A	C	NA	NSPR	N
1706020114900	POLE CR	V	B	C	NA	NSPR	N
1706020106100	REDFISH LK CR		WEIR-DS	B	NA	NSPR	Y
1706020106100	REDFISH LK CR		LOWER	B	NA	NSPR	Y
1706020106900	SALMON R	3	BRA	C	NA	NSPR	Y
1706020103900	SALMON R	RBNSN-BAR		B	NA	WSUM	Y
1706020106000	SALMON R	2	B	B	NA	NSPR	Y
1706020106900	SALMON R	3	A	B	NA	NSPR	Y
1706020106900	SALMON R	3	B	B	NA	NSPR	Y
1706020108200	SALMON R	7	A	C	NA	NSPR	Y
1706020106900	SALMON R	3	BR-B	C	NA	NSPR	Y
1706020107100	SALMON R	5	A	B	NA	NSPR	Y
1706020107500	SALMON R	5	B	B	NA	NSPR	Y
1706020107501	SALMON R	6	A	C	NA	NSPR	Y
1706020108400	SALMON R	10	A	B	NA	NSPR	Y
1706020108400	SALMON R	10	B	C	NA	NSPR	Y
1706020107001	SALMON R	4	A	C	NA	NSPR	Y
1706020107100	SALMON R	4	B	C	NA	NSPR	Y
1706020107000	SALMON R	4	BRA	C	NA	NSPR	Y
1706020107501	SALMON R	6	B	B	NA	NSPR	Y
1706020108200	SALMON R	7	5A	N	NA	NSPR	Y
1706020108200	SALMON R	7	B	C	NA	NSPR	Y
1706020108200	SALMON R	8	A	C	NA	NSPR	Y
1706020108200	SALMON R	8	B	C	NA	NSPR	Y
1706020108400	SALMON R	9	A	C	NA	NSPR	Y
1706020108400	SALMON R	9	B	B	NA	NSPR	Y
1706020110700	SALMON R, E FK	ABOVE WEIR3		B	NAB	NSPR	Y
1706020110700	SALMON R, E FK	ABOVE WEIR2		C	NAB	NSPR	Y
1706020109800	SALMON R, E FK	BELOW WEIRB		B	NAB	NSPR	Y
1706020108300	SMILEY CR		A	B	NA	NSPR	N

APPENA-1

Appendix A-1. Continued.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
1706020108300	SMILEY CR		B	C	NA	NSPR	N
1706020103500	THOMPSON CR	ABOVE	TWO-POLE	B	NA	NSPR	Y
1706020103500	THOMPSON CR	BELOW	1	B	NA	NSPR	Y
1706020105300	VALLEY CR	3	A	C	NA	NSPR	Y
1706020105400	VALLEY CR	3	B	C	NA	NSPR	Y
1706020105500	VALLEY CR	6	B	B	NA	NSPR	Y
1706020105200	VALLEY CR		B	C	NA	NSPR	Y
** N Fk Salmon R and Panther Cr							
1706020302300	MOYER CR	ABOVE	MO1	C	NA	NSPR	N
1706020302200	PANTHER CR	ABOVE	PC10	C	NA	NSPR	N
1706020302000	PANTHER CR	ABOVE	PC9	C	NA	NSPR	N
1706020300600	PANTHER CR	DS-CLEAR	PC1	B	NA	NSPR	N
1706020301000	PANTHER CR	DS-BIGD	PC4	B	NA	NSPR	N
1706020301400	PANTHER CR	DS-BLACKB	PC6	C	NA	NSPR	N
1706020303400	PINE CR	ABOVE	BRIDGE	B	NA	NSPR	N
1706020303400	PINE CR	ABOVE	SAWMILL	B	NA	NSPR	N
1706020307700	SALMON R, N FK		DAHLONEG	B	NA	NSPR	Y
1706020307500	SALMON R, N FK		HUGHES	C	NA	NSPR	Y
** Lemhi R							
1706020402600	BEAR VALLEY CR	HC1	B	C	NA	NSPR	Y
1706020408300	BIG SPRINGS CR	LEM1	A	C	NA	NSPR	Y
1706020402800	HAYDEN CR	HC2	B	B	NA	NSPR	Y
1706020402400	HAYDEN CR	HC3	B	B	NA	NSPR	Y
1706020403700	LEMHI R	LEM2	B	C	NA	NSPR	Y
1706020403700	LEMHI R	LEM3	A	C	NA	NSPR	Y
** Upper Middle Fk Salmon R							
1706020502800	BEAR VALLEY CR	7	BIG-MDWL	C	WB	WSPR	Y
1706020502800	BEAR VALLEY CR	9	B	C	WB	WSPR	Y
1706020502300	BEAR VALLEY CR		A	B	WB	WSPR	Y
1706020502500	BEAR VALLEY CR	2	A	C	WB	WSPR	Y
1706020502500	BEAR VALLEY CR	2	B	C	WB	WSPR	Y
1706020502700	BEAR VALLEY CR	3	A	C	WB	WSPR	Y
1706020502800	BEAR VALLEY CR	5	A	C	WB	WSPR	Y
1706020508400	BEARSKIN CR		3	C	WB	WSPR	Y
1706020508400	BEARSKIN CR	2	NEW	C	WB	WSPR	Y
1706020508400	BEARSKIN CR		5	C	WB	WSPR	Y
1706020508400	BEARSKIN CR		B	C	WB	WSPR	Y
1706020508400	BEARSKIN CR		4	C	WB	WSPR	Y
1706020508400	BEARSKIN CR		6	C	WB	WSPR	Y
1706020503600	BEAVER CR		A	B	WB	WSPR	Y
1706020503600	BEAVER CR	3	B	C	WB	WSPR	Y
1706020503400	CAPE HORN CR		A	C	WB	WSPR	Y
1706020503400	CAPE HORN CR	2	B	C	WB	WSPR	Y
1706020502600	ELK CR		A	C	WB	WSPR	Y
1706020502600	ELK CR	2	A	C	WB	WSPR	Y
1706020502600	ELK CR	2	B	C	WB	WSPR	Y
1706020502600	ELK CR		B	C	WB	WSPR	Y
1706020503503	KNAPP CR		A	C	WB	WSPR	Y
1706020503503	KNAPP CR	2	B	C	WB	WSPR	Y
1706020503503	KNAPP CR		BELOWDIVER	C	WB	WSPR	Y
1706020505000	LOON CR		L1	B	WB	WSPR	Y
1706020505000	LOON CR		L2	B	WB	WSPR	Y
1706020505000	LOON CR		1	C	WB	WSPR	Y
1706020505000	LOON CR		2	C	WB	WSPR	Y
1706020505000	LOON CR		LNM-1	B	WB	WSPR	Y
1706020500300	MARBLE CR	LOWER	L1	B	WB	WSPR	Y
1706020500600	MARBLE CR	UPPER	MAR1	B	WB	WSPR	Y
1706020500501	MARBLE CR	UPPER	MAR2	B	WB	WSPR	Y
1706020503200	MARSH CR		A	B	WB	WSPR	Y
1706020503200	MARSH CR		B	B	WB	WSPR	Y

APPENA-1

Appendix A-1. Continued.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
1706020503500	MARSH CR	4	B	C	WB	WSPR	Y
1706020506300	MARSH CR	5	A	C	WB	WSPR	Y
1706020506300	MARSH CR	6	A	C	WB	WSPR	Y
1706020501100	PISTOL CR		L1	B	WB	WSPR	Y
1706020501100	PISTOL CR		L2	B	WB	WSPR	Y
1706020502100	SULPHUR CR	3	A	B	WB	WSPR	Y
1706020502100	SULPHUR CR	4	A	C	WB	WSPR	Y
1706020502100	SULPHUR CR	4	B	B	WB	WSPR	Y
** Lower Middle Fk Salmon R							
1706020600700	BIG CR	LOWER	L1	B	WB	WSPR	Y
1706020601100	BIG CR	MIDDLE	TAYLOR-1	C	WB	WSPR	Y
1706020603200	BIG CR	UPPER	BIG	B	WB	WSPR	Y
1706020603200	BIG CR	UPPER	BIG-1	B	WB	WSPR	Y
1706020605100	CAMAS CR		L1	B	WB	WSPR	Y
1706020605200	CAMAS CR		1	C	WB	WSPR	Y
1706020605200	CAMAS CR		2	C	WB	WSPR	Y
1706020605200	CAMAS CR		CAM1	B	WB	WSPR	Y
1706020603700	MONUYMENTAL CR, W FK		MONO	C	WB	WSPR	Y
1706020603600	MONUMENTAL CR		MON5	C	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON1	B	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON2	B	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON3	B	WB	WSPR	Y
1706020604100	RUSH CR		1	C	WB	WSPR	Y
** Upper Salmon R canyon							
1706020704200	CHAMBERLAIN CR		CHA1	B	WA	WSPR	Y
1706020704400	CHAMBERLAIN CR		CHA4	C	WA	WSPR	Y
1706020704300	CAHMBERLAIN CR, W FK		CHA2	C	WA	WSPR	Y
1706020704300	CHAMBERLAIN CR, W FK		CHA3	B	WA	WSPR	Y
** S Fk Salmon R							
1706020803200	DOLLAR CR		1	B	WB	WSUM	Y
1706020804700	JOHNSON CR	ABOVE	M1	C	WB	NSUM	N
1706020804700	JOHNSON CR	ABOVE	M2	C	WB	NSUM	N
1706020804700	JOHNSON CR	ABOVE	M3	C	WB	NSUM	N
1706020804700	JOHNSON CR	ABOVE	PW1A	B	WB	NSUM	N
1706020804700	JOHNSON CR	ABOVE	PW3A	B	WB	NSUM	N
1706020804400	JOHNSON CR	LOWER	L2	B	WB	NSUM	Y
1706020804400	JOHNSON CR	LOWER	L3	B	WB	NSUM	Y
1706020804700	JOHNSON CR	BELOW	PW3B	B	WB	NSUM	Y
1706020804700	JOHNSON CR	ABOVE	PW1A	B	WB	NSUM	N
1706020801700	LAKE CR		BURGDORF	C	WB	NSUM	Y
1706020801700	LAKE CR		WILLOW	C	WB	WSUM	Y
1706020802000	LICK CR		L3	B	WB	WSUM	Y
1706020809800	ROCK CR	ABOVE	M1	C	WB	NSUM	N
1706020804200	SALMON R, E FK S FK		7	B	WB	NSUM	Y
1706020804300	SALMON R, E FK S FK		6	B	WB	NSUM	Y
1706020802400	SALMON R, S FK		14	B	WB	NSUM	Y
1706020802200	SALMON R, S FK		16	B	WB	NSUM	Y
1706020802900	SALMON R, S FK		11	B	WB	NSUM	Y
1706020803400	SALMON R, S FK		5	C	WB	NSUM	Y
1706020803300	SALMON R, S FK		7	B	WB	NSUM	Y
1706020802900	SALMON R, S FK		POVERTY	C	WB	NSUM	Y
1706020803600	SALMON R, S FK	STOLLE	1	C	WB	NSUM	Y
1706020803600	SALMON R, S FK	STOLLE	2	C	WB	NSUM	Y
1706020804300	SALMON R, E FK S FK		3	B	WB	NSUM	N
1706020807400	SAND CR	ABOVE	M2	C	WB	NSUM	N
1706020801601	SECESH R		GROUSE	C	WB	NSUM	Y
1706020801601	SECESH R		LONG-GULCH	C	WB	NSUM	Y
1706020801601	SECESH R		U-SCSH-MDW	C	WB	NSUM	Y

Appendix A-1. Continued.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
** Lower Salmon R canyon							
1706020902500	SLATE CR		12.1	B	NA	WSPR	Y
1706020902500	SLATE CR		4.3	B	NA	WSPR	Y
1706020902500	SLATE CR		6.7	B	NA	WSPR	Y
1706020902500	SLATE CR		8.1	B	NA	WSPR	Y
1706020903000	WHITEBIRD CR		1	B	WA	WSPR	Y
1706020903000	WHITEBIRD CR		2	B	WA	WSPR	Y
1706020903000	WHITEBIRD CR		3	B	WA	NSPR	Y
** Little Salmon R							
1706021000900	BOULDER CR	ABOVE	1	B	NA	NSPR	D
1706021000900	BOULDER CR	ABOVE	2	B	NA	NSPR	D
1706021000900	BOULDER CR	BELOW	3	B	NA	NSPR	Y
1706021000900	BOULDER CR	BELOW	5	B	NA	NSPR	Y
1706021002600	HAZARD CR		HAZ1	B	NA	NSPR	Y
1706021001000	LITTLE SALMON R		1	B	NA	NSPR	Y
1706021000700	LITTLE SALMON R		2	B	NA	NSPR	Y
1706021000800	LITTLE SALMON R		BLM16.6	B	NA	NSPR	Y
1706021000200	RAPID R		RAP2	B	WA	NSPR	Y
1706021000300	RAPID R, W FK		RAP1	B	WA	NSPR	Y
" Upper Se1‹.a							
1706030102400	BEAR CR			B	WB	NSPR	
706030102400	BEAR CR			3	WB	NSPR	Y
1706030101900	DEEP CR		CACTUS	B	WB	NSPR	Y
1706030101900	DEEP CR		SCIMITAR	C	WB	NSPR	Y
706030100800	RUNNING CR			B	WB	NSPR	
706030100800	RUNNING CR			B	WB	NSPR	
706030101300	SELWAY R		_.: TLECW	B	WB	NSPR	Y
706030101300	SELWAY R		MAG-XING	C	WB	NSPR	Y
1706030101400	SELWAY R		HEL!_SHA'L	B	WB	NSPR	
06000102110	WHITE CAP CR		BRIDGE	B	NB	NSPR	
006030102100	RHITE CAB CR		UPPER	B	WB	NSPR	Y
00210	1		IIL_ERNEOS	3	...I❑	NSPR	
Lower ; e							
106030204 7'0U	3UTTE		FS1	B	WB	NSPR	i
706030204700	BUTTE CR		FS2	3	WB	NSPR	N
1706030204700	BUTTE CR		FS3	B	WB	NSPR	N
1706030204700	BUTTE CR		FS4	B	WB	NSPR	N
1706030204000	GEDNEY CR	LOWER	1	B	WB	NSPR	Y
1706030204000	GEDNEY CR	LOWER	2	B	WB	NSPR	Y
1706030200701	MEADOW CR		FS1		WB	NSPR	N
1706030200701	MEADOW CR		FS10		WB	NSPR	N
1706030200701	MEADOW CR		FS2		WB	NSPR	N
1706030200701	MEADOW CR		FS3		WB	NSPR	N
1706030200701	MEADOW CR		FS4		WB	NSPR	N
1706030200701	MEADOW CR		FS5		WB	NSPR	N
1706030200701	MEADOW CR		FS6		WB	NSPR	N
1706030200701	MEADOW CR		FS7		WB	NSPR	N
1706030200701	MEADOW CR		FS8		WB	NSPR	N
1706030200701	MEADOW CR		FS9		WB	NSPR	N
1706030200500	MEADOW CR		SLIMS-CAMP	B	WB	NSPR	Y
1706030200500	MEADOW CR	ABOVE	2	B	WB	NSPR	Y
1706030201500	MOOSE CR		3	B	WB	NSPR	Y
1706030201400	MOOSE CR		1	B	WB	NSPR	Y
1706030201400	MOOSE CR		2	B	WB	NSPR	Y
1706030203000	MOOSE CR, N FK		4	B	WB	NSPR	Y
1706030201000	OTTER CR			B	WB	NSPR	Y
1706030204800	SABLE CR		FS1	B	WB	NSPR	Y
1706030204800	SABLE CR		FS2	B	WB	NSPR	Y

Appendix A-1. Continued.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
1706030204800	SABLE CR		FS3	B	WB	NSPR	Y
1706030204800	SABLE CR		FS4	B	WB	NSPR	Y
1706030204800	SABLE CR		FS5	B	WB	NSPR	Y
1706030203900	THREE LINKS CR		1	B	WB	NSPR	Y
** Lochsa R							
1706030301900	BRUSHY FK CR		1	B	NB	NSPR	Y
1706030304300	BRUSHY FK CR		2	B	NB	NSPR	Y
1706030304600	CROOKED FK CR		1	B	NB	NSPR	Y
1706030304600	CROOKED FK CR		2	B	NB	NSPR	Y
1706030304600	CROOKED FK CR	BELOW	1B	B	NB	NSPR	Y
1706030304200	CROOKED FK CR	BELOW	2B	B	NB	NSPR	Y
1706030300400	FIRE CR	MOUTH	1	B	NB	NSPR	N
1706030300400	FIRE CR	UPPER	2	B	NB	NSPR	N
1706030305400	FISH CR		1	B	NB	NSPR	Y
1706030305400	FISH CR		2	B	NB	NSPR	Y
1706030302300	LOCHSA R		L1	B	NB	NSPR	Y
1706030300800	LOCHSA R		L4	B	NB	NSPR	Y
1706030300600	OLD MAN CR		1	B	NB	NSPR	N
1706030300600	OLD MAN CR		POOL	B	NB	NSPR	Y
1706030301800	POST OFFICE CR		1	B	NB	NSPR	Y
1706030301800	POST OFFICE CR		2	B	NB	NSPR	Y
1706030306600	SPLIT CR	LOWER	1	B	NB	NSPR	N
1706030306600	SPLIT CR	LOWER	2	B	NB	NSPR	N
1706030301900	WARM SPRINGS CR	LOWER	1	B	NB	NSPR	Y
1706030301900	WHITE SAND CR	LOWER	WS1	B	NB	NSPR	Y
**S Fk Clearwater R							
1706030504100	AMERICAN R		1	C	NB	NSPR	Y
1706030504100	AMERICAN R		2	C	NB	NSPR	Y
1706030503301	CROOKED R	I	CONTROLI	B	NB	NSPR	Y
1706030503301	CROOKED R	I	SILLLOGB	B	NB	NSPR	Y
1706030503300	CROOKED R	II	CONTROL2	B	NB	NSPR	Y
1706030503300	CROOKED R	II	TREAT2	B	NB	NSPR	Y
1706030503301	CROOKED R	H	OR0GRAN1	B	NB	NSPR	Y
1706030503300	CROOKED R	II	CONTROLI	B	NB	NSPR	Y
1706030503300	CROOKED R	II	TREAT1	B	NB	NSPR	Y
1706030503300	CROOKED R	C	CAN1	B	NB	NSPR	Y
1706030503300	CROOKED R	C	CAN2	B	NB	NSPR	Y
1706030503300	CROOKED R	C	CAN3	B	NB	NSPR	Y
1706030503301	CROOKED R	I	BOULDERA	B	NB	NSPR	Y
1706030503301	CROOKED R	I	BOULDERB	B	NB	NSPR	Y
1706030503301	CROOKED R	I	C0NTROL2	B	NB	NSPR	Y
1706030503301	CROOKED R	I	SILLLOGA	B	NB	NSPR	Y
1706030503301	CROOKED R	III	NATURALI	C	NB	NSPR	Y
1706030503300	CROOKED R	III	NATURAL2	C	NB	NSPR	Y
1706030503300	CROOKED R	III	NATURAL3	C	NB	NSPR	Y
1706030503300	CROOKED R	IV	MEANDER1	C	NB	NSPR	Y
1706030503300	CROOKED R	IV	MEANDER2	C	NB	NSPR	Y
1706030503300	CROOKED R	IV	MEANDER3	C	NB	NSPR	Y
1706030507200	CROOKED R	H	EF1	B	NB	NSPR	Y
1706030507200	CROOKED R	H	EF2	B	NB	NSPR	Y
1706030503302	CROOKED R	H	WF1	B	NB	NSPR	Y
1706030503302	CROOKED R	H	WF2	B	NB	NSPR	Y
1706030501600	JOHNS CR	LOWER	1	B	NB	NSPR	Y
1706030501600	JOHNS CR	UPPER	2	B	NB	NSPR	Y
1706030501600	JOHNS CR	0.5	1	B	NB	NSPR	Y
1706030501600	JOHNS CR	1	2	B	NB	NSPR	Y
1706030502000	JOHNS CR	2	3	B	NB	NSPR	Y
1706030504800	MEADOW CR	CANYON	MILEP0S2	B	NB	NSPR	D
1706030504800	MEADOW CR	MEADOW	GRAZED	C	NB	NSPR	D

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Appendix A-1. Continued.

EPA Stream Reach	Stream Name	Stratum	SeLLion	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No?
1706030504300	NEWSOME CR		1	C	NB	NSPR	Y
1706030504300	NEWSOME CR		4 MI	C	NB	NSPR	Y
1706030504300	NEWSOME CR		SIDE CH.		NB	NSPR	Y
1706030504300	NEWSOME CR	MOUTH	MOUTH		NB	NSPR	Y
1706030503800	RED R		CONTROLI	C	NB	NSPR	Y
1706030503800	RED R		CONTROL2	V	NB	NSPR	Y
1706030503800	RED R	II	TREAT2	B	NB	NSPR	Y
1706030503600	RED R	IV	CONTROL2	C	NB	NSPR	Y
1706030503600	RED R	V	CONTROL2	C	NB	NSPR	Y
1706030503600	RED R	V	TREAT2	C	NB	NSPR	Y
1706030503800	RED R	II	CONTROL2	B	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEFIA	B	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEF2A	C	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEF1B	B	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEF2B	C	NB	NSPR	Y
1706030503000	TENMILE CR		FS1		NB	NSPR	Y
1706030503000	TENMILE CR		FS2		NB	NSPR	Y
1706030503000	TENMILE CR		FS3		NB	NSPR	Y
1706030503000	TENMILE CR		FS4		NB	NSPR	Y
1706030503000	TENMILE CR		FS5		NB	NSPR	Y
** Lower Clearwater R							
1706030602200	BIG CANYON CR		1	B	WA	NSPR	N
1706030603700	ELDORADO CR	ABOVE	$BRIDGE		NB	NSPR	D
1706030603700	ELDORADO CR	ABOVE	2$BRIDGE		NB	NSPR	D
1706030603700	ELDORADO CR	DOLLAR	1.5U		NB	NSPR	D
1706030603700	ELDORADO CR	BELOW	1B	B	NB	NSPR	Y
1706030603700	ELDORADO CR	ABOVE	1HG	B	NB	NSPR	D
1706030603700	ELDORADO CR	ABOVE	2LG	C	NB	NSPR	D
1706030603700	ELDORADO CR		SEC BRIDGE	B	NB	NSPR	N
1706030603600	LOLO CR	DWNSTRM	DS6	B	NB	NSPR	Y
1706030603600	LOLO CR	DWNSTRM	RUN6		NB	NSPR	Y
1706030603600	LOLO CR	UPSTRM	8303	C	NB	NSPR	Y
1706030603900	LOLO CR	UPSTRM	8360	B	NB	NSPR	Y
1706030603900	LOLO CR	UPSTRM	RUN1	B	NB	NSPR	Y
1706030603900	LOLO CR	UPSTRM	RUN7	B	NB	NSPR	Y

APPENA-1

Appendix A-2. Form used for recording physical data at parr monitoring and evaluation sections.

Stream ______________ Date ______________ Collectors ______________

Length (M) ______________ Comments ______________

EPA Reach # ______________ Vertical Drop (M) ______________

Gradient (%) ______________

PROGRAM:

Stratum ______________

Section ______________

Channel Type: ______________

B = Confined, Sediment flushing

C = Meandered, depositional

__ = Other, see Rosgen's Channel Types

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Transect [1](m) from downstream	Width [1](m)	Habitat	Location on transect (l to r)	Depth [1](m)	% Substrate Class by Area							
					Sand 0	Gravel (up to 3")	Rubble (3" to 12")	Boulder (>12")	Bedrock			
		___	1/4	___	___	___	___	___	___			
		___	1/2	___	___	___	___	___	___			
			3/4									
		___	1/4	___	___	___	___	___	___			
		___	1/2	___	___	___	___	___	___			
			3/4									
		___	1/4	___	___	___	___	___	___			
		___	1/2	___	___	___	___	___	___			
			3/4									
		___	1/4	___	___	___	___	___	___			
		___	1/2	___	___	___	___	___	___			
			3/4									
		___	1/4	___	___	___	___	___	___			
		___	1/2	___	___	___	___	___	___			
			3/4									

Habitat: 1 = Pool; 2 = Run; 3 = Pocket Water; 4 = Riffle; 5 = Backwater

Appendix A-3. Form used for recording biological (fish population) data at parr monitoring and evaluation sections.

STREAM ______________ DATE ______________ COLLECTORS ______________

Conductivity ______________ Weather ______________

EPA Reach # ______________ Comments ______________

Temperature ______________ ______________

Stratum ______________ Section Length (m) ______________

Section ______________ Section Width (m) ______________
(n≥4) ______________

Section Area ______________ M^2 Visibility: (m) ______________

METHODS: ( ) Snorkel (circle corridor or entire stream width)
( ) Electrofish
( ) Other ______________

Length Class (in)	RAINBOW - STEELHEAD				RESIDENT SPECIES			
	Total	Wild & Natural	Adipose Clipped	Hatchery Catchabl	Cutthroat	Brook	Bull	Whtfish
< 2								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
> 12 specify length								

Age 0 Chinook		Adults
Age 1 Chinook		Redds

Appendix A-4. Percent surface sand and density of wild chinook and steelhead parr in established monitoring sections in the heavily-sedimented Bear Valley/Elk Creek drainage and control streams in the Middle Fork Salmon River drainage, 1984-90.

Stream Condition	Stream	Section	% Sand	Chinook Parr/100m[e] 1984	1985	1986	1987	198	1989	1990	Steelhead Parr/100 m[t] 1984	1985	1986	1987	198	1989	199
Excessive Sediment	Bear Valley Cr	2A	43	5.9	1.9	3.0	0.9	4.2	0.8	0.0	3.0	0.1	0.1	0.0	0.0	0.0	0.1
		2B	71	2.2	0.0	0.3	0.0	0.0	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
		3A	25		1.0	4.7	7.7	5.6	6.4	1.1		0.0	0.8	0.1	0.3	0.0	0.2
		5A	28		0.2	4.1	1.3	2.9	4.3	1.2		0.0	0.0	0.0	0.2	0.1	0.1
		9B	55		0.0	0.0	2.2	2.6	1.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
	Elk Cr	1A	44		0.4	0.0	0.1	0.1	0.5	1.0		0.4	0.0	0.0	0.1	0.0	0.0
		1B	54		1.4	0.6	0.1	11.9	5.2	0.0		1.4	0.6	0.0	0.3	0.0	0.0
"		2A	53	0.5	0.0	0.0	0.0	0.2	9.4	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0
		2B	37		1.1	0.2	3.8	11.6	5.1	0.0		1.1	0.2	0.0	0.3	0.0	0.0
		Means:	46	2.9	0.7	1.4	1.8	4.3	3.7	0.38	1.1	0.3	0.2	0.0	0.1	0.0	0.04
Control Streams	Knapp Cr	1A	26		23.6	7.2	10.4	11.1	21.5	5.4		1.1	0.7	3.5	3.4	2.2	0.8
	Beaver Cr	1A	4		12.9	7.2	0.5	9.8	13.4	0.6		1.4	0.0	0.1	1.2	0.5	0.0
		3B	11		10.8	28.6	5.9	26.8	6.5	0.3		1.2	2.1	0.7	2.4	1.4	0.2
	Cape	2B	20		49.0	10.7	96.8	55.7	50.7	28.6		0.2	0.0	0.0	0.0	0.0	0.3
	Horn Cr	1A	8		34.7	14.5	39.4	40.7	20.3	0.7		0.1	0.6	0.9	4.2	0.1	0.2
	Sulfur Cr	4A	36		0.1	25.8	39.9	24.1	55.6	0.5		0.0	0.3	3.2	3.4	4.4	2.4
		4B	30		18.1	62.6	18.8	67.9	107.3	15.7		1.0	1.0	0.2	4.4	5.0	3.4
		Control	20		23.1	22.4	30.2	33.7	39.3	7.4		0.7	0.7	1.2	2.7	1.9	1.04